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Telephone Engineer

VOL. 31, No. 1 JANUARY, 1927 CHICAGO

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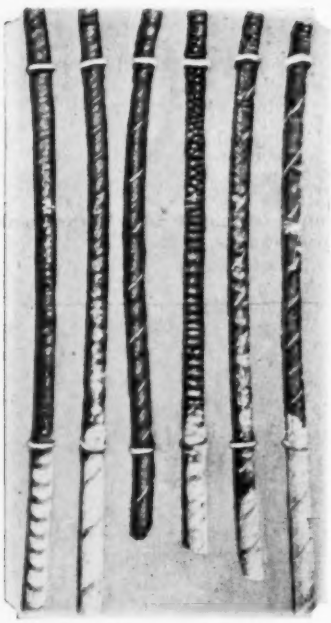

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Telephone Engineer

Volume 31 JANUARY, 1927 Number 1

The Menace of the Leaning Pole

Several months ago, this journal published a carefully prepared and well written article by John M. Walshe on the mechanics of pole line construction. The author of this article went to some pains to work out in readable form the effects of several factors which enter into the strength of pole line construction.

Among other things, he showed, in some detail, that the strength of the line is materially decreased if the poles are not set and maintained in a vertical position. We do not believe that this matter has been given the thought it deserves. We admit that it failed to impress us to the extent it should until we had the opportunity of inspecting the damage done by a recent sleet storm.

In the particular area we visited, the ice accumulated to the thickness of approximately one-half inch in radius. In one section of three miles, over forty poles were pushed over, while in another section of a mile not a pole was out of place. The load on the two sections was approximately the same. Soil, wind and ice conditions were apparently identical and the general construction was alike.

Inquiring as to the cause of damage being heavily inflicted in one place and not in the other, we learned that the entire line had suffered from a lighter storm some months before and that many of the poles had been thrown out of line and were leaning. On account of the press of other work, the job of straightening up the line had been delayed, so that only the one-mile section had been worked over.

When the ice came, the ground was soft from preceding rains and the load on the leaning poles caused them to kick out from the soft earth and fall over. On the straightened poles, the load was vertical and the poles were not disturbed.

There seemed to be only one difference, namely: that a few dollars had been spent on the maintenance of the one section, while the other section had not received such maintenance. After our survey of the situation, we were more than ever convinced that the cost of eliminating leaning poles may save much at some later date.

* * *

Winter Worry Antidote—Build Lines Right

We are taking a page from the book of Arthur Brisbane and are writing this editorial as we travel on one of the famous Trans-Continental trains of the country. The country through which we are passing is in the great Middle West and our comments are necessarily colored by its influence.

As we observe the telephone lines that cross and parallel our route, we are led to think of the things that are in the minds of the men who construct, maintain and manage them. At this time of year, somewhere in the recesses of his mind, the haunting spectre of the always possible sleet storm which in a few hours may level the sturdiest of lines.

Sleet storms are almost an annual occurrence in the section through which we are traveling, and yet we wonder that the lesson to be learned from them seldom sinks deep enough into the consciousness of telephone men that they profit by it.

Year after year, sections of ramshackle lines go down under ice and wind—and the lines are rebuilt in the same haphazard way. The experienced eye does not need the assistance of a slide rule or a logarithm table to see why they fail. Small poles, long spans, insecure anchoring—all contribute their share to the lack of strength that spells destruction.

As the train rolls along, we see the lines of an occasional plant that, we venture, never suffers severely from sleet. The poles are sturdy and no longer than road clearances require; the lines are straight and the poles set plumb; corners are well raked and strongly guyed; spans are short; wires are pulled up evenly and every wire is properly tied to its insulator.

Here is a line that the ordinary sleet storm will not damage and which the extraordinary storm will

not wreck. Its builder and owner have learned that the best insurance against sleet is the line that is properly built and maintained, and that a plant composed of such line is one of the best antidotes for worry in the winter season.

* * *

Inventory Time in the Telephone World

Pages might be written of the New Year as inventory time, when stock is taken of all the various phases of life and business. However, in writing our part of the subject we are going to eliminate all of the various sentimental and inspirational elements of the subject and stick to one, hard, concrete business aspect of the most prosaic form of the annual inventory, namely, the counting and pricing of the materials and supplies in the telephone warehouse.

Every telephone company takes, or should take, an annual inventory of its materials and supplies. When it is completed and the prices have been applied and extended, the inventory serves its principal purpose, that of making adjustments of the books so that a true statement of profit and loss may be drawn off. Then the sheets are filed carefully because commission orders say that they shall be retained.

We often have wondered how many telephone companies make use of their inventories in connection with their plans for construction during the succeeding season: How many companies have worked out standard stocks that should be carried of the various articles used; Is the inventory ever analyzed to find out if an overstock exists of certain articles and an understock of others; Does it show that the warehouse is cluttered up with scrap and obsolete stock that well could be turned into cash by a visit to the junk dealer; Is there a reasonable supply of the various materials to care for a small emergency within the time that is required to get materials from the supplier?

* * *

Trans-Atlantic Telephony an Accomplished Feat

Just as the New Year was opening, came the announcement that commercial radio telephone service was to be inaugurated between New York and London. January 7th, after a brief preliminary ceremony, the circuit was thrown open for service to the public. The interest in the event was so great that applications for time came pouring in and the calls had to be taken in sequence just as toll tickets are taken in the busy hour.

An interesting feature of the development of the radio telephone to the point of being able to talk at such distances is that there is no one who really can be called the inventor. Radio telephony has no Morse, Bell or Marconi. It is rather the work of hundreds of scientists and investigators, each contributing a share to the art. Scientists will remember DeForest, Fessenden, Heising, Langmuir and the many others who did their share, but the great public will have no one to associate with the system as its inventor. It is the fruit of co-operative effort rather than of brilliant individual invention.

While the system is open for commercial use, this does not mean that the work is completed. It is not out of reason to predict that the single circuit now available soon will be inadequate for the business that must be compressed into the 4½ hours that are common to the New York and London business day. Static and the problem of secrecy will provide problems for future solution, as well as the problem of securing additional channels and the extension of the service to other countries.

Language difficulties as well as technical difficulties must be overcome, but in time painstaking research will find a way through all the intricate mazes of the problem and the service will be available to every one who needs it, whenever that need arises.

* * *

I. C. C. Depreciation Order Is Published

The long expected depreciation order of the Interstate Commerce Commission finally has been published. For more than four years the commission has been studying the question of depreciation of railroads and telephone companies and the present order represents the conclusion of the commission as to the proper methods of accounting in connection with the fixed capital or plant accounts of carriers and communication companies.

From the viewpoint of telephone companies, it is interesting to note that the commission has upheld the practice of the telephone industry is creating a depreciation reserve against the practice of charging retirements at the time made, as contended for by railways, gas and electric utilities. Since the commission has taken this view, it follows that there will be no radical change in the methods of depreciation accounting for telephone companies. The order, like the accounting orders, applies only to the Class A, B, and C companies, Class D companies being exempted.

While there is no radical change in the method of accounting to be used, individual companies will find details of accounting that must be modified to meet the requirements of the order. Companies which have not yet done so, are required to distribute their plant investment into the various accounts provided and must carry these accounts, as provided by the accounting system, beginning Jan. 1, 1928. Prior to Sept. 1, 1927, they must file with state commission an estimate showing the annual rate of depreciation applicable to each class of plant from which a composite rate is to be determined.

Personnel Activities Smooth Out Company's Work

By H. F. McCULLA

Commercial Engineer, Lincoln (Neb.) Telephone and Telegraph Company

Economists of good repute agree that the year 1880 marked the beginning of a new epoch in the industrial life of our nation. In the light of subsequent events this epoch was termed the "Industrial Revolution" so termed because it marked the period of transition from the old hand method of commodity production to the modern machine method.

For a period of approximately twenty years the struggle waged hotly between the defenders of the old method and the advocates of the new method. In the end science and the process of inevitable evolution won the supremacy of the machine method of production was definitely established. However, the passing of the hand made method, which was manufacturing in the truest sense of the word, intensified a problem which demanded and is demanding more and more the very serious consideration of the employers and directors of labor. This problem is the one of properly caring for the employe group or personnel.

It is true that this problem of personnel was not a new problem for as long as man had directed the efforts of his fellowman the personnel problem had been present. However, under the old method of hand production the supervisor of labor was intimately in touch with his employes or subordinates. This intimate contact was due to two factors; first, under the old method of production the supervisor was with but rare exception the master craftsman of the shop and as such was chosen from among his associates to direct the efforts of his fellow craftsman less qualified than he. Second, under the old method the number of employes in any one group was of necessity smaller, thereby permitting of a more intimate contact between supervisor and subordinate.

This contact, as close and constant as it was, led logically to an opportunity for the growth of mutual interest and confidence on the part of both supervisor and supervised. The establishment of this mutual interest and confidence eliminated to a great extent the personnel problem, for in daily and frequent contact between employer and employed or supervisor and supervised lay the opportunity for the solution of any questions that might arise and that might have led to misunderstandings and difficulties under less favorable conditions.

H. F. McCulla

By this same token the introduction of machinery and machine methods of production led to the disassociation of employer and employed or of supervisor and supervised. This disassociation came about from two main causes; first, the economy and efficiency in supervising comparatively large groups of employes; second, the consequent loss of a constant and beneficial contact between supervisor and supervised. In keeping pace with the evolution of the machine method of production these two causes were inevitably present and although beneficial from the standpoint of economical and efficient production they gave impetus to the rapidly growing problem of personnel.

An indication of the recognition of a need for the consideration of the personnel problem came with the organization by employers of so-called Welfare Committees, Associations or Clubs. These organizations soon eliminated themselves for as so-called Welfare Organizations they smacked so much of patronage and charity that in many instances they did more harm than good. However, they did have the effect of tending to show the need for serious consideration along this line but under the guise of another motive and without the smack of patronage or charity. In time the problem was considered in its true light and eventually was recognized for what it was, that is, a personnel problem and not a welfare matter. This led to a more or less universal practice of terming all activities carried on in behalf of the betterment of the working and social conditions of employes as personnel activities. Today personnel activities are recognized as an essential part of the activities of nearly all the larger business organizations and are rapidly gaining recognition as essential on the part of some of the smaller business organizations.

In spite of the fact that virtually all of the larger business institutions have accepted as necessary the problem of personnel activity and have met it with a reasonable program of activities, there is still some reluctance on the part of the management of smaller organizations to accept the theory.

An example of application of the theory of personnel activities to a small public utility in a middle western state may be of interest. The manager of this particular utility had shown good judgment in his financing program and had built up his public relations to a point where he could safely entrust the running of the routine affairs of the business to his employes, and turn his attention to the affairs of other business. This he proceeded to do. The affairs of business of the utility proceeded in a very orderly and satisfactory manner for a period of two or three years and Mr. Manager was justly proud of his organization and of his employe personnel. Later in telling the story of his experience he said, "As foresighted and careful as I was in matters of financing, accounting and public relations yet I overlooked and neglected the most important single factor in the success or failure of my business—viz. my employes." There is a note of real warning as well as a note of tragedy wrapped up in that statement. In this instance all due attention had been given to all the factors involved in the success or failure of this utility, or so the Manager thought, yet he had overlooked as scores of others are overlooking today, the vital factor of proper consideration for the human factor in business.

The story of this Manager's failure may prove a timely warning to others. He said, "Constant attention to the details of administration and routine matters had resulted in the building up of an organization that functioned smoothly and efficiently." Daily contact with the

various employes of the company kept alive a sincere feeling of kindly interest in and regard for the business and social welfare of each employe. While this daily contact was maintained employe grievance and difficulties of all kinds were quickly and thoroughly ironed out for a complete confidence existed between employer and employe.

After two or three years of consistent success I felt secure in turning the routine details and duties of the utility business over to my employes and I turned my attention to other business affairs in which I was interested and which for some time had been rather neglected because of my efforts to place the utility's affairs on a sound going concern basis.

I kept in reasonably close contact with utility affairs for a year and then began to grow from them as other affairs pressed me for more attention and for more time. Another year brought to me a false sense of security concerning the feeling of the employes of the utility for my lack of the old daily contact with them had led to this false feeling of well being. One day I was startled to receive the resignation of my Wire Chief and Chief Operator, both of whom had been in my employ since my first connection with the utility. A hurried though thorough investigation of the causes of the tendered resignations revealed quite clearly the fact that I had so sadly neglected both of these employes that they lost a great deal of their former faith and confidence in me and in the organization which I represented.

The loss of these two employes meant the loss of a real tangible investment in time and money. At the same time their going meant even a greater loss to the utility in those intangible factors which are involved in the relationship of every employe of a utility to that portion of the public at large with which he or she comes in contact.

This story as related by Mr. Public Utility Manager brings home to us a two-fold message and warning. First, that we cannot and dare not for a moment afford to overlook or neglect the very important factor of personnel and proper personnel activities; second, that the loss of an employe means a loss much greater than can possibly be measured in the dollars and cents represented by the daily, weekly or monthly wage paid the employe.

Consideration of the particular case which we have just recited brings to us the following conclusions, viz., that real management necessitates not only a knowledge of production, financing, accounting, and marketing, but also a thorough knowledge of all the factors involved in the proper handling of the employe group or personnel.

An analogy has been built up around the factors involved in purchasing, preparing for service, operating, and maintaining a piece of apparatus and the hiring, training, supervising and retaining on the payroll of an employe.

The portion of the analogy pertaining to the piece of apparatus concerned a telephone switchboard and details as follows:

1. The selection of a telephone switchboard from among many switchboards after careful consideration had been given the various makes and their relative virtues.
2. The careful preparation and installation of the switchboard for service so that a maximum of efficient service might be assured.
3. The proper maintenance of the switchboard by competent repairmen.
4. The providing of properly trained operators so that the full value of the switchboard might be realized.
5. The proper maintenance of the switchboard by competent repairmen so it might be retained in service as long as possible, thereby permitting the fullest realization on the investment.

If much care and consideration had been given a piece of apparatus such as a switchboard is it not reasonable to assume that at least the same amount of consideration might be given a new employe?

The portion of the analogy applying to the employe detailed as follows:

1. The careful selection of the employe from among a list of applicants after due thought and consideration had been given all of the applicants.
2. The proper instruction of the chosen employe in the policies and practices of the organization as well as concerning his or her immediate duties.
3. Proper supervision of the new employe so that the maximum amount of value might be realized from the efforts of the employe.
4. Proper observation of all the factors of personnel consideration so that the new employe might be retained on the payroll for as long a period of time as possible, thereby permitting the fullest realization on the investment of time and money which has been made in the new employe.

The analogy as presented appears reasonable enough as it concerns both the telephone switchboard and the new employe, but the question that naturally arises is: How can that portion of the analogy applying to the new employe be made a practicable reality?

Skepticism gives way to reluctant belief when we stop to admit that organizations of various types and sizes have demonstrated the feasibility of proper personnel activities.

A summary of the factors of personnel activities as carried on by five representative utilities is detailed here with the thought that it will be helpful in furnishing a starting point for other organizations in this particular field. For the purpose of clarity the analogy outlined previously is adhered to in formulating the outline of the summary.

1. Choice of employe
   - a. Interview.
   - b. Investigation of reputation and references.
   - c. Physical examination.
2. Preparation for service
   - a. Explanation to employe of ideals, practices, and policies of organition.
   - b. Induction into proper atmosphere and environment.
   - c. Proper attitude on part of older employes.
   - d. Thorough instruction concerning duties to be performed.
3. Performance
   - a. Proper working conditions.
   - b. Proper supervision.
   - c. Proper working tools.
4. Retention of employe on payroll
   - a. Wages and promotion.
   - b. Opportunity to learn more about the business.
   - c. Opportunity to become financially interested in business.
   - d. Opportunity to express opinions and ideas for the betterment of business.
     1. Through employe representation.
     2. Through a suggestion system.
   - e. Knowledge of interest of employer in times of emergencies.
     1. Financial assistance in times of emergency.
     2. Sickness and accident benefits.
     3. Leave of absence without break in service record.
   - f. Knowledge of interest in social life.
     1. Athletic clubs.
     2. Musical organizations.
   - g. Knowledge of proper provision for old age.
     1. Through pension plan.

After viewing this array of factors involved in the personnel problem some may be prone to dismmiss the matter as one beyond the need of their particular organization. But if you are so inclined you are first requested to study carefully the summarized statistics gathered from a representative group of five public utilities who have for several years given careful and consistent attention to the subject of personnel and personnel activities. These statistics concern the factors of labor turnover and of the purchase by employes of stock in the utilities. Both of these factors are essential items in the broad subject of personnel activities and as such have been referred to previously in this article.

Not all of the improvements so noticeably reflected in the statistics quoted can

be safely attributed to the two factors of personnel activities concerned but it is reasonable to assume that these factors have had a very material part in the improvement shown and indicate quite clearly what may be accomplished.

Labor Turnover per 1,000 Employes

Year 1922	Year 1925
49%	34%

Net reduction in percentage of labor turnover 15%

Resulting in the following change in average life of employe service record.

Prior to 1922	Period 1922 to 1925 Incl.
2 Years.	3 Years.

An increase of 50% in service life of employe.

STOCK PURCHASE PLAN FOR EMPLOYES.

Results per 1,000 Employes.

Year 1920

60 employes purchasing stock.

Year 1925.

400 employes purchasing stock.

An increase in the number of employes purchasing stock under the Employes' Purchase Plan of 666⅔% in five year period.

—*International Newsreel Photo.*

Walter S. Gifford, president of the A. T. and T. Co., in the midst of a group of Bell officials and other dignitaries, opens trans-Atlantic telephone service by talking to London from his office at 195 Broadway, New York City.

Industry Passes Another Milepost as New York-London Service Opens

New York City.—"Please connect me with Sir Evelyn Murray in London." This instruction, spoken into his office telephone by Walter S. Gifford, president of the A. T. & T. Co. marked the completion of the radio telephone link on a practical exchange basis between the metropolis of the new world with that of the old.

This service went through its first day with the customary cross section of telephonic conversations, and in the background the Bell staff of specialists worked in a frantic fight with static while the epochal exchange of telephone messages was in progress. The formalities of the official opening were dispensed with in the conversation between the Bell chieftain and the secretary of the British postoffice. At 8:30 a. m. (New York time) the static began its rampage and slightly delayed the opening ceremonies. With the normal static condition rated as 100 per cent, the telephone men placed the conditions on the opening day as only about 25 per cent as good as normal. A feature of the opening ceremonies was the sound of St. Paul's chimes at London being transmitted to New York as the famous chimes rang out 1:45.

There were 31 calls, not counting Mr. Gifford's put through during the opening day. The first commercial conversation was between A. S. Ochs, publisher of the New York Times, and Geoffrey Dawson, editor of the London Times. Other conversations treated of a $5,000,000 deal in foreign exchange, a 100 carload order of lumber, newspaper and motion picture company business, financial matters and an exchange of greetings between Mayor Walker of New York City and the Lord Mayor of London. The rush of business kept the service in action until 6 p. m. (New York time), which was considerably past the set closing hour. During the middle of the day there were interruptions of service due to static, and for two long periods no messages could be sent on this account. The interference in sending was worse from London than at the American end of the span. At one time the English operators despaired of being able to continue the service during the day, when the English sunset static disturbance forced the operators to turn the system over to the technical men for readjustment.

The opening day of the tran-atlantic telephone service was signalized in the stock market when A. T. & T. stock advanced to $151.75, its highest mark since 1911.

—*International Newsreel Photo.*

A general view in the valve power unit room at the G. P. O. radio station at Hillmorton, Eng., through which calls to and from New York City are being handled.

Bismarck Is Placed as Telephone Pioneer

One of the first men in Europe to see the possibilities of the telephone was Bismarck. From the beginning he realized its value in holding a nation together, and early in the fall of 1877 he ordered a line built between his palace in Berlin and his farm at Varzin which were 230 miles apart. This was thus the first long distance line in Europe.

Some Practical Hints on Transpositions

By R. V. ACHATZ*

Much has been said about the necessity of keeping telephone lines in a state of balance in order to reduce inductive effects in the nature of cross talk and noise from foreign circuits. Most telephone men understand that this means that insulation should be good and uniform on all wires, that the conductors of a circuit or of a phantom group should be of the same resistance and that a proper system of transpositions should be used. Nearly every telephone man knows how to maintain the insulation of a line and the greater number are able to determine whether there are high resistance joints, the existence of which is the most frequent cause of unequal conductor resistances. If the evidence to be obtained from examination of many plants is to be believed. Not all of them understand or appreciate the importance of the transposition problem or how to install and maintain a system of transpositions. Therefore it may not be out of place to offer some suggestions concerning transpositions.

It is not necessary to discuss the reasons for transposing lines nor the theory underlying the effect on the circuit. These are pretty well understood, but there are many points concerning the application of transpositions to given lines that may not be clear and it is with these points we propose to concern ourselves.

Systems of Transposition.

To begin, it may be said that transpositions must be put into the line in conformity with some definite plan. Merely going out and cutting in transpositions at various points may be the cause of making a line more noisy and increasing cross talk rather than the cause of reducing these effects. The various systems of transposition are well known and have been published so frequently that every telephone man should have access to the drawings showing their arrangement. On this account only a brief explanation will be given here.

The oldest system is the ABC scheme which was the first to be applied generally. For short lines it served very well, but was not sufficiently well balanced to be satisfactory for long lines. There are still many lines transposed according to this system, however, where the results are sufficiently good to make a change unnecessary.

The next system was the so-called "standard" system in which the line is broken up into sections of approximately eight miles in length and each section is designed so that every circuit is balanced against every other circuit. Modifications of this system for shorter length sections are known as the X, Y and Z Sections.

With the development of power transmission systems, exposed line systems were developed. These systems, of which the E, L and R sections are typical, are designed to give better balance between the circuits of the communication line and to co-ordinate better with transpositions in the power circuits. On account of the greater number of transpositions they are more expensive to install than the standard system.

There are also special systems that may be laid out for particular cases, but as these require special engineering no general discussion can cover all of the conditions. As a typical special layout may be mentioned the transposition of all circuits on a given line at certain points to neutralize power line induction.

Selection of a System.

While most telephone men have the layouts for the various systems, they are not always certain as to which system should be adopted for a given situation. As stated above, there are many lines transposed according to the ABC scheme and where no trouble from cross talk or noise occurs, this system is adequate. It can frequently be used on leads carrying farm lines where circuits drop off at various points and where the lengths of the lines are not great. It is not recommended for new lines where there is possibility of future power line parallel.

The "standard" system is still used where no power line exposure exists or where the exposure is not severe. Ordinarily it is adequate where the transmission line is of relatively low voltage and the separation is the width of the ordinary road. We are familiar with several cases where power lines up to 13,200 volts parallel toll lines for distances from two or three up to ten miles and where the use of the standard system properly installed has kept the noise down to the point where it is scarcely noticeable.

The exposed line sections are used where the nature of the power exposure require them. On existing lines, they are only installed if the standard section does not produce quite lines. They are sometimes used where entirely new lines are built as the cost of installing is not so much greater when the transpositions can be made as the wire is being strung.

Short and Long Sections.

The choice between the short and long sections will depend upon the distances between "S" poles, the location of which will be discussed presently. For unexposed lines, if the section is less than about 800 feet in length it is ordinarily left untransposed. For sections between 800 feet and one-fourth mile the "X" section is used and between one-fourth and one-half miles the "Y" section is used. Between one and one-half and four miles, the "Z" section is used and over four miles the standard section. For exposed lines the "R" section or several "R" sections in succession are used for shorter distances. The "L" section is used where sixteen transportation poles can be provided in the section and the "E" section where 32 transposition poles can be located in the section.

Location of "S" Poles.

An "S" pole is the pole at the beginning or end of a transposition section and is so named because it is stencilled with the letter S. The location of "S" poles is the first step in laying out a transposition scheme for application to a given line after the general type of transposition system is adopted. Usually the first "S" pole is the pole at which the open wire toll lines start after leaving the central office. The location of the next "S" pole and the succeeding ones depend upon conditions in the line. The simplest case would be an extremely long line without branches or power exposures. Starting from the first "S" pole the distance of 41,600 feet would be measured and the next "S" pole located at that point. Succeeding "S" poles would be located at distances of 41,600 feet.

In practice most of us in the smaller companies find few cases where the standard distance can be used. Due to branching of lines and changes in exposure it is necesary to locate the "S" poles with reference to the line rather than at the standard distance. Ordinarily "S" poles should be located at all important junction points and at the ends of the line. In determining whether a junc-

**Amplification of remarks made at a meeting of the Benton Telephone Association, at Lafayette, Indiana.*

tion line is to be classed as important, farmer lines are usually neglected and any junction point where less than one-third of the circuits leave the main line will not require an "S" pole in the main line. The pole where the branch line leaves, however, will be an "S" pole in the branch line. In exposed lines, "S" poles must be located with respect to the ends of the exposure or important changes in the character of the exposure, such as transformer stations where the voltage of the transmission line changes or where there is a large change in the separation between power and telephone lines.

Occasionally "S" poles are required at the end of long sections of cable or where the character of construction of the telephone line changes. The location of "S" poles on loaded lines need not be discussed here.

Location of Transportation Poles.

Having determined the location of the "S" poles and the distances between them, the type of section will be selected and this determines the number of transposition poles required in the section. Theoretically, the transposition poles should be spaced absolutely equally but in practice this is seldom done except for loaded lines or lines requiring special treatment. Usually the nearest pole is taken.

The procedure of locating transposition poles may be illustrated best by an example. Suppose two "S" poles have been located at a distance of 36,000 feet apart and the standard system is to be used. Since the standard system requires 32 transposition poles the distance between transposition poles will be 1/32 of 36,800 or 1,150 feet. Starting from the first "S" pole, a distance of 1,150 feet is measured and the point marked. It will seldom be found that there is a pole exactly opposite this point so the nearest pole to the point is chosen for the transposition pole. Starting again from the point (not the pole) a distance of 1,150 feet is measured and the point marked. The nearest pole is chosen for the second transposition pole and a new measurement started from the point. It will be noticed that all measurements are made from the point rather than the pole.

The method of locating transposition poles by counting a certain number of poles usually results in much more irregular spacing than the method of making actual measurements. If the transposition pole falls on a corner pole, it is usually shifted to the next pole in a straight line Short pieces of cable or twisted pair wires are ordinarily neglected except that care is taken that the wires are kept straight at the ends.

Treatment of Exchange Circuits.

Where exchange circuits such as long farm lines are carried on toll poles they are transposed according to the regular system through the distance where they are located on the toll poles. The same thing may be said of all lines that branch at unimportant junction points within the section.

Checking Existing Lines.

When new lines are to be added or changes are to be made in existing lines, it is often advisable to make a complete check of the existing transposition system. A surprisingly large number of irregularities may be found in lines that were supposed to be properly transposed. Among some of the more common faults will be found the following:

1. Transposition poles irregularly spaced.
2. Circuits transposed at points not required by drawing.
3. Circuits not transposed where required.
4. Wrong type of phantom transposition.

Foremen and linemen do not always realize the importance of accuracy in transposing circuits and all of the faults are likely to be found in lines where the transposing has not been watched. We have seen cases of supposedly properly made single pin transpositions which turned out to be nothing more than the two wires of the circuit tied to the transposition glass and returning to their original position without change.

MacKinnon Urges Consideration of Employees' Interests

Chicago, Ill.—In a general bulletin of New Year greeting President F. B. MacKinnon of the United States Independent Telephone Association makes an earnest suggestion that the interests of loyal and able Independent employees be given careful consideration when sales or mergers are being planned. The Independent chief says:

"The attention of the public, through the interests of investment bankers, has been directed to the telephone industry in an entirely different way. One of the results of this interest has been the sale of some of the Independent properties and thereby the creation of a feeling of unrest among the employes of some of those companies as to their future. I wish to urge the employes not to be disturbed. The men who are investing in the properties must realize that those properties have to be operated by experienced men and women, that the telephone business is a business which can not be learned in a day, and therefore a change in ownership of the property in most cases should not and will not mean any change in employes. During the coming year there will, in all probability, be more changes in ownership and more tempting offers made to the owners of properties to sell them to advantage. To those owners I want to express the hope that they will give due consideration to the effect of the sale upon the employes who have given the thought and human effort necessary to the creation of the successful company, and that they will have due regard to the effect of the sale upon the telephone service in their community, the rendering of which service has become an obligation resting upon the owner of the property.

"Upon the veterans of the industry I want to urge a closer cooperation in State and National Associations looking to better service, better financing, better net results, and a better feeling of confidence on the part of the personnel. Over ninety per cent of our properties are being operated by veterans in the telephone business. This should remain true, as only with men and women imbued with the ideals for service that have always filled the hearts and minds of the men and women of the telephone group will we be able to continue to give the service that has been extended so wonderfully and is so greatly appreciated by the public. The Independent group is operating four and a half million telephones. Scattered as they are through more than nine thousand different companies, we have a great task to unite these companies into a compact working organization which will encourage the stronger and support the weaker members.

At the beginning of this new year we want to urge upon all members of this Association more activity in the organizations, more effect in enrolling your neighbor companies in the organizations, and more use of the organizations."

New Catalogue on Megger Test Sets

Philadelphia, Pa.—James G. Biddle, dealer in electrical instruments has issued a new catalog No. 1145 entitled "Megger Insulation Testing Instruments." This catalog describes the "Megger" Test Set which is used by the larger telephone and electric companies for measuring high resistances such as insulation of telephone cables. The principle of operation is given and the various types of the instrument are shown.

Brownfield, Tex.—Z. A. Kimbro, at one time a representative for the Monarch Telephone Mfg. Co., has been made district manager for the State Telephone Co.

"How Is Your Service?"—Query Guides the C. & P.

"Service from the subscriber's point of view" may be a new phrase, but it is not a new thought. Getting the subscriber's opinion, in one form or another, is always going on. Sometimes it is done on a large scale, the first example of which was the personal letter which President A. E. Berry of the Chesapeake and Potomac Telephone Co. sent in 1922 to more than 100,000 Maryland subscribers.

During the summer of 1926 the idea was again put to work. In the form of an insert with telephone bills, 312,827 questionnaires were sent to the telephone subscribers in Maryland, Virginia, West Virginia and the District of Columbia, in addition to 40,000 letters sent by Mr. Berry to Maryland subscribers, and personal interviews by telephone managers in all parts of the territory.

There was another object in finding out what the subscribers were thinking about. For several years every department had been intensively studying every phase of its work. All departments had embarked on a broad program of service improvement. "In every move decided upon by the departments we," says the company's Transmitter, in telling of the survey, "had tried to put ourselves in the subscriber's place, to think of what we were doing as it would affect the subscriber. It seemed to us that if we knew in this way all the things that were troubling subscribers, we could classify their complaints and criticisms in a way that would give us a very good check on the completeness of our program of service improvement. That finally was just what was done with all replies from subscribers. Every department made a very careful classification of things affecting their work and it is gratifying to know that there were few matters mentioned that we had not ourselves listed down for attention.

Now, if you ask a man to write and frankly let you know if there is anything the matter with the service, you should not be startled if in reply he tells you things that are not altogether complimentary. The chances are about even that you will hear at least a mild complaint, with perhaps a suggestion for improvement. Multiply this one man by 312,827 and the possibility for criticism, gentle or otherwise, is almost unlimited.

One would think—knowing how busy most people are—that if a subscriber had no complaint or suggestion to offer, he would disregard the invitation to write and decide it is always a good policy to let well enough alone. One certainly could not reasonably expect that 73 per cent of those answering the questionnaire would say that the service is perfectly all right. Yet, that is what they did. And it is, indeed, gratifying.

But what about the 27 per cent who didn't say the service was perfectly all right? Well, that's where the Company had an opportunity to put into action its expressed desire to give the public the kind of service that satisfies.

The questionnaires were mailed to our subscribers on a staggered plan and as was expected, replies started coming in shortly after the questionnaires reached the subscribers, and every day for several weeks they continued to pile in.

A special force was organized at Washington and Baltimore to handle and classify the great mass of correspondence at these two points, but at other places in the territory the work was handled, and handled well, by the regular forces. It might surprise our readers to learn that each subscriber who took the trouble to return the questionnaire was personally thanked. Letters that did not require investigation were acknowledged the same day. Complaints were investigated immediately and if possible disposed of at once. Where a more lengthy investigation was required, the letter was acknowledged immediately and the subscriber told of what was being done.

At every point in the territory, the committee handling the correspondence, including the special forces at Baltimore and Washington, was made up of representatives of Plant, Traffic and Commercial departments, respectively. This committee kept a complete record of every complaint received, and took it up for attention with the department or departments involved. An absence of red tape marked the whole procedure. The telephone was used freely and writing reduced to a minimum. Everything was done to speed up things and clean up cases as fast as they were reported by subscribers.

All cases taken up with the several departments were followed up until the work required was completed. For instance, if a subscriber wrote that he had no complaint to make of the service but would appreciate a new telephone set—having had the present one for a long time—the case was not considered closed until the new telephone had been installed and the subscriber called to see if everything was satisfactory.

Many of the subscribers who complained did not say just what the difficulty seemed to be; and of course, the next step was to find out definitely but courteously what the trouble was in order that it might be remedied.

In classifying the letters they were placed in two general groups, commendatory and otherwise. Unless the letter was an unqualified commendation, the rule was to class it as otherwise. For instance, let us take a letter in which the wording is something like this:

"Your telephone service is perfectly all right, but I wish you'd send me a new telephone directory. I didn't get one the last time they were distributed."

Should that be classed as a commendatory letter? No. The reference to the non-delivery of the directory keeps it out of that class.

Those letters which were classified as non-commendatory were further divided

TO OUR PATRONS:

We are trying in every way to give you good telephone service and there is no feature of the many operations involved to which we are not giving every care and attention.

But the final test of our performance is how *you* feel about it. Will you not tell us whether the service you are receiving is in all respects satisfactory? Have you had any troubles that have not been promptly corrected? Can you think of anything we are failing to do and might do to make our service better?

We have printed on the opposite page six questions covering some of the more important phases of the service. Won't you please fill in your answers to these questions, detach and return the slip to us when you pay the accompanying bill?

Your co-operation in this matter will be greatly appreciated and may be the means of bringing about a real improvement in your service.

THE CHESAPEAKE & POTOMAC TELEPHONE COMPANY

A page from the questionnaire sent to subscribers in Maryland, Virginia, West Virginia and the District of Columbia.

as partly favorable or unfavorable. Both of these groups were then divided according to the department involved.

Into the Plant group went all letters having to do with the work done by that department—moving telephones, relocating poles, locating trouble and things of this nature.

The Traffic group was made up of letters referring to slow answers, wrong numbers, inability to get party, and like matters.

Commercial took what was left, and this remainder included not only the letters referring to matters handled in our Business Offices, but all letters concerning public relations and Company policy.

The letters referred to Traffic for attention mentioned slow answers, delay in completing local calls, incorrect busy, and don't answer reports, cut-offs, being called in error or failure to receive an incoming call. These were the major things mentioned; there were several other things of minor consequence.

Cases referred to Plant were made up of complaints in reference to inside wiring, private branch exchange, cables, terminals, line wire, drag wire, protectors, delayed installations and things of a similar nature.

In Commercial there was a greater variety of things criticized. Of course, in connection with some of these only one or two complaints were received. For instance, one subscriber in the whole C. and P. territory offered written objection to the practice of listings in telephone directory showing the name of an apartment house as the address. One subscriber in the whole territory complains of the non-delivery of telephone bills. One subscriber in the whole territory claims he is unable to reach the Business Office by telephone. And one subscriber thinks that subscribers should be given free service from public telephones.

Here are some of the more obvious things criticized in the letters relating principally to matters handled by Commercial and Accounting: overcharge on messages, non-delivery of telephone directories, errors in directory, inattention to mail, bills not accurate, bills not understandable.

The foregoing is the story of the questionnaire, the method of handling it and the results. But it is always interesting to get a glance of the actual letters or comments, so lets take a look at some of them. And because bouquets make more pleasant reading than brick-bats, let's take some of the commendatory ones first.

Here's a brief and pleasant comment: "I am glad to state that my dealings with the C. and P. have been perfectly satisfactory."

A subscriber observes that he has lived in several cities in various parts of the country in the past ten years and that he is now "getting the best service I ever had." Another simply notes: "Quite satisfactory in every way." And another: "We are fully satisfied with the Company's service. The operators and all the employes as well as the officials have accorded to us every possible courtesy."

A Washington business man who had recently established himself in the city wrote: "Have been very pleased with your very good service. I send this because I am much surprised at the way your company extends courtesy and service. This is my first month here in Washington and I cannot tell you how greatly your service has helped my business. I do all my ordering from New York by long distance telephone. Thank you."

Now for some of the brick-bats. And it must be admitted that most of these are mild in tone.

One subscriber says: "A written communication from myself to the Business Office was never answered. Why?"

Another writes: "Operator service very satisfactory, but had to send three reports before having telephone repaired."

In noting unsatisfactory conditions, kindly give details, if possible.

Are your calls completed satisfactorily? .....

When you report your telephone out of order, is the trouble promptly cleared?.....

Are your orders for establishment and changes of service cared for promptly and satisfactorily?.....

.....

Are your bills understandable and accurate? .....

.....

Are your questions regarding particular items explained or adjusted to your satisfaction?.....

.....

Are your dealings with our Business Office or other Departments satisfactory? .....

.....

Name of Subscriber.....

Telephone No.....

Space is provided on the reverse side for your General Comments.

The questions concerning their service which subscribers were requested to answer. On the outside of the leaflet, space was provided for general comments.

In the space under the paragraph asking the subscriber to add a few words of general nature regarding the service and the attention received from the Company, a subscriber wrote "I would need asbestos paper." His state of mind, it was afterwards ascertained, was brought about by an inaccurate telephone bill.

Every questionnaire received was given a personal reply by mail or telephone and every complaint adjusted. In some cases the reply was made up of intimate detail. In other cases, a courteous acknowledgement was sufficient.

Every effort was made to show the telephone subscriber that in sending out the questionnaire the Company was sincere and not merely fishing for compliments.

The District of Columbia showed the greatest percentage of replies—5.4. The percentage throughout the whole territory was 3.7.

That this figure is not larger may be due to the fact that the managers throughout the whole territory, for several weeks previous to the questionnaire, had been interviewing subscribers concerning the service, and these interviewed subscribers, having given their views verbally, probably did not fill out the questionnaire.

At the close of the campaign, a follow-up insert was mailed to all subscribers, containing in brief form some of the results of the questionnaire. In this follow-up the Company took occasion to emphasize the ease with which subscribers can take up matters with the Company.

Graybar Head Sees Rosy New Year

New York City. — Albert Lincoln Salt, President of the Graybar Electric Co., in his annual review statement says:

"Under our new name, Garybar, we have had in 1926 the greatest business year in our history. We have added four distributing branches to our system, reaching from coast to coast, enlarged our organization and increased our selling facilities. Our business has never been as good—our prospects never any better. 1927 after all is just another name for the continuation of 1926. We see nothing on the business horizon that would lead us to look for any marked change in our business. This electrical business of which we are a part is so new, so broad, its ramifications touch so many industries and so many people that it is always susceptible of expansion.

"While our books have not been closed for the year, we estimate sales of approximately $77,000,000 in 1926, as compared to a volume of $66,000,000 in 1925—which up to that time was our most satisfactory year.

New York Employes Get Life Insurance

New York City.—More than 64,000 of the New York Telephone Co. employees will be offered easy payment life insurance policies, the payments to be deducted from their salaries. Eight life insurance companies are associated in the plan.

The Monarch "Unit-Position Section

**Combining the Economy of Uni
with the Advantages of Individu**

THIS new Monarch switchboard offers to operating companies two features not often found associated. It is made up of individual sections each having separate positional wiring, and is specially engineered to meet the requirements of the exchange it is to serve.

The flexibility of the unit position sections will adequately provide for any amount of expansion of either toll or local positions and lines to the full capacity of 1200 associated multiple line equipments.

The line equipment may be of the convertible type, installed for magneto lines and converted to common battery lines individually when desired, or common battery line equipments of either multiple or non-multiple type as required.

The sections are furnished with lift out type rear panels which, when removed, allow unobstructed entrance to the entire rear equipment of the switchboard. This arrangement is of the greatest convenience in both installing and maintaining the switchboard.

"For Greatest Servi

American Elec

State an
Chica
Succes
Monarch Telep

American

Monarch
Telephone Equipment and Supplies

Equations an Important Division of Mathematics

By F. J. DOMMERQUE
Fellow A. I. E. E.

42. Equations of the First Degree

In the preceding articles on mathematics and physics we have applied equations in a matter of fact way, we now will give a presentation of this subject in a more systematical and methodical order. When writing on the value of graphs identical and conditional equations were defined and their geometrical meaning was shown in an elementary way. Some of the applications made previously will be mentioned again, which is "good business" as repetition is the surest road to knowledge, certainly when the subject is studied from its various angles.

An equation states the equality existing between two quantities distinguished as the known and the unknown quantity. In any equation certain transpositions can be made which do not change the correctness of the equation. One of these transpositions is effected by subtraction, a transposition we have applied before. As an example take the equation $x + b = c$. Subtracting b from both sides of the equation we obtain $x = c - b$. Another example is $x(a + b) = c$; dividing both sides of the equation by $(a + b)$ we obtain $x = \frac{c}{a+b}$. This is a transposition by division.

Equations are classified according to the form in which the unknown quantity x appears. If x appears in the first power only the equation is said to be of the first degree. If x appears in the form x^2, that is, in the second power, the equation is said to be of the second degree. There may be present in the equation also terms with x in the first power. If x appears in the form x^3, it is an equation of the third degree. Briefly, the highest exponent of x determines the degree of an equation.

Each class of equations has its standard form to which any in the class may be reduced. The standard form of an equation of the first degree is $ax = b$, which may also be written as $ax - b = o$; the solution is $x = \frac{b}{a}$. If, for example, the equation $4x - 6 = 10(2 - x) + 6(x - 4)$ is given, it is expedient to bring first all the terms containing the unknown quantity x to one side of the equation. In the given equation we must first remove the parentheses thus: $4x - 6 = 20 - 10x + 6x - 24$ or $4x + 10x - 6x = 20 - 24 + 6$ or $8x = 2$, whence $x = \frac{2}{8} = \frac{1}{4}$.

We will not take up time with more examples, there will be plenty applications in physics.

The majority of equations of the first degree met with in practical applications contain more than one unknown variable quantity, but they all are independent of each other. Previously we spoke of y as a function of x; the x in that case was an independent variable but y was a dependent variable, but in the case under consideration x and y are both independent variables.

Whenever we have to deal with several independent variables, we need as many equations as there are variables to effect a solution. The standard form of two equations with two unknown variables may be written:

$$a x + b y = c \quad \ldots\ldots (1)$$
$$a_1 x + b_1 y = c_1 \quad \ldots\ldots (2)$$

The standard form of equations containing three unknown quantities may be written as:

$$a x + b y + c z = d$$
$$a_1 x + b_1 y + c_1 z = d_1$$
$$a_2 x + b_2 y + c_2 z = d_2$$

and generally the standard form of an equation of the first degree containing n unknown quantities as:

$$a x + b y + c z + \ldots\ldots = A$$
$$a_1 x + b_1 y + c_1 z + \ldots\ldots = A_1$$
$$\ldots\ldots$$
$$a_n x + b_n y + c_n z + \ldots\ldots = A_n,$$

there must be *n independent simultaneous equations*. To solve these equations the n equations are combined by elimination until a single equation is obtained containing but one unknown quantity. The principal methods of elimination are: (a) "Elimination by Substitution." Given two independent simultaneous equations containing two unknown quantities of the form:

$$a x + b y = c \quad \ldots\ldots (1)$$
$$a_1 x + b_1 y = c_1 \quad \ldots\ldots (2)$$

Find the value of one of the unknown quantities in terms of the other from either of the given equations, thus from equation (1):

$$x = \frac{c - by}{a} \quad \ldots\ldots (3)$$

Substitute this value in the other equation and obtain $a_1 \frac{c - by}{a} + b_1 y = c_1$, whence $\frac{a_1 c - a_1 by}{a} + b_1 y = c_1$, or by multiplying both sides by a $a_1 c - a_1 by + ab_1 y = ac_1$, or $y(ab_1 - a_1 b) = ac_1 - a_1 c$; this gives

$$y = \frac{ac_1 - a_1 c}{ab_1 - a_1 b} \quad \ldots\ldots (4)$$

Substitution of this value for y in the equation (3) gives:

$$x = \frac{c - b\frac{ac_1 - a_1 c}{ab_1 - a_1 b}}{a} = \frac{c - \frac{abc_1 - a_1 bc}{ab_1 - a_1 b}}{a}$$
$$= \frac{ab_1 c - a_1 bc - abc_1 + a_1 bc}{a(ab_1 - a_1 b)} \text{ or}$$
$$x = \frac{b_1 c - bc_1}{ab_1 - a_1 b} \quad \ldots\ldots (5)$$

We have not gone into minute detail to develop one expression from the other, it is left to the reader to do this for practice, but we will add an example:

Given the equations:

$$5x + 7y = 31$$
$$2x + 3y = 13$$

Applying equation (4) we obtain:

$$y = \frac{ac_1 - a_1 c}{ab_1 - a_1 b} = \frac{5 \times 13 - 2 \times 31}{5 \times 3 - 2 \times 7} =$$
$$\frac{65 - 62}{15 - 14} = \frac{3}{1} = 3.$$

Substitute the value 3 for 5 into equation (3) and obtain $x = \frac{c - by}{a} =$

$$\frac{31 - 7 \times 3}{5} = \frac{31 - 21}{5} = \frac{10}{5} = 2.$$

In both, the general form and the example, we could have started with the determination of the value of y and then substituted this value in the other given equation.

If there are given three equations containing three unknown quantities, find the value of one of the unknown quantities from one of the given equations and substitute this value in the two other equations, thereby obtaining two equations containing but two unknown quantities, which can be eliminated as explained above. The found values being substituted in the expression, the value of the first unknown quantity is determined.

(b) "Elimination by Addition and Subtraction." Given again the two equations containing two unknown quantities; multiply the equations by such numbers or quantities as will make the coefficient of one of the unknown quantities the

*Tenth article on Telephone Mathematics and Physics.

same in the two resulting equations; in the case of equations (1) and (2) multiply both sides of equation (1) by b_1 and both sides of the equation (2) by b, obtaining

$$ab_1x + bb_1y = b_1c$$
$$a_1bx + bb_1y = bc_1$$

It will be seen that the signs of the terms having the same coefficient, namely, bb_1, are alike, hence by subtracting one equation from the other, we eliminate y altogether, and obtain $x(ab_1 - a_1b) = b_1c - bc_1$. This gives for x the same value as found before in equation (5), namely, $x = \frac{b_1c - bc_1}{ab_1 - a_1b}$.

Inserting this value of x in one of the given equations gives the value of y. It the signs of the terms having the same coefficient are unlike, the two equations would have to be added instead one subtracted from the other.

Taking as an example the two equations:

$$5x + 7y = 31$$
$$2x + 3y = 13$$

The first equation is to be multiplied by 3 and the second one by 7 to eliminate y, obtaining:

$$15x + 21y = 93$$
$$14x + 21y = 91$$

Subtracting the lower equation from the upper, it results $x = 2$. Substituting this value into either of the two given equations gives $y = 3$.

Given three equations containing three unknown quantities, multiply the given equations by such numbers or quantities as will make the coefficient of one of the unknown quantities the same in the resulting equations. Combine these equations by addition or subtraction, so as to form a new set of equations containing but two unknown quantities. Continue operation with these two equations and obtain an equation containing but one unknown quantity. Find the value of this unknown quantity, substitute it in either of the equations containing only two unknown quantities, and determine the value of a second unknown quantity. Finally substitute these values in either of the equations containing three unknown quantities and determine the value of the third unknown quantity.

(c) "Elimination by Combination." From the given equations (1) and (2) calculate x. Thus from equation (1) $x = \frac{c - by}{a}$ and from equation (2) $x = \frac{c_1 - b_1y}{a_1}$.

As the left sides of these two equations are the same or equal, the right sides must be equal also, that is, it must be $\frac{c - by}{a} = \frac{c_1 - b_1y}{a_1}$.

It results the value of y as $\frac{ac_1 - a_1c}{ab_1 - a_1b}$, the same as before in equation (4).

The value of x is determined in the same manner.

Using as an example again the equations

$$5x + 7y = 31$$
$$2x + 3y = 13$$

we find from the first equation $x = \frac{31 - 7y}{5}$ and from the second equation $x = \frac{13 - 3y}{2}$, whence $\frac{31 - 7y}{5} = \frac{13 - 3y}{2}$, giving $y = 3$. Substituting this value in $x = \frac{31 - 7y}{5}$, gives $x = 2$.

43. Graphical Representation of an Equation of the First Degree

We have previously stated the general form of an equation of the first degree as $ax = b$. For the application to physics we must take in consideration that physical laws are not only stated by formulae but also by graphs. Of the latter a discussion was given in the second paper on "Telephone Mathematics and Physics" and particularly in section seven of that paper. As graphs involve the system of co-ordinates we must give to the above equation a different form so as to bring the ordinate in also besides the abscissa x. Therefore, we write the general equation of the first degree as $y = a + bx$, which is different in form but more representative or rather more practical for graphical representation. Here y is a dependent variable. By assigning to x different values, a corresponding number of values will be obtained for y. In the paper on graphs we have arranged the values of x and y in tabular form and then taking the corresponding values as co-ordinates have plotted a curve or a straight line. Doing this for the equation $y = a + bx$ we will find that the pairs of values give a series of points, all of which lie on a straight line. For this reason equations of the first degree are also termed "linear" equations.

Starting with $x = o$ we obtain $y = a + b \times o$. As $b \times o$ is again o, we have $y = a$. This means that the straight line cuts the Y axis at a distance "a" from the origin. In mathematics this distance is called the *"Y intercept."* If we had given y the value o, we would have obtained $x = -\frac{a}{b}$, which would mean that the straight line cuts the X axis at a distance $-\frac{a}{b}$ from the origin. Then this distance would be called the *"X intercept."* For $a = o$, y would reduce to bx, which means the line passes through the origin.

We have already learned in the just mentioned section seven to plot a line at an angle of 45° to the X axis and have found that the tabulated values of x and y were alike; that is, that the equation was $y = x$. We now will take an example from physics, namely, to plot values for Ohm's law. If we write this law as $I = \frac{E}{R}$, we can plot the values of E along the X axis, taking E as the independent variable, and the values of I along the Y axis, taking I as the dependent variable, this leaves R as a constant; that is, we let R in above equation have constantly one and the same value. Let R have the constant value 1 and let the scale be the same for the X axis and Y axis. Then I would be the same as E for any value of E and we would have again the 45° angle line of section seven as shown in Fig. 47, wherein this line is marked $R = 1$. Suppose we give to R the constant value 2. We then find for $E = 4$ the value $I = \frac{4}{2} = 2$; for $E = 12$ the value $I = \frac{12}{2} = 6$; for $E = 20$ the value $\frac{20}{2} = 10$. Plotting these values we find that all of them lie on a straight line, which is marked $R = 2$ in Fig. 47.

A straight line is completely determined by two of its points, therefore in graphs of equations of the first degree it is only necessary to construct two points and draw a line through them. The lines in Fig. 47, designated by $R = 1$ and $R = 2$ form an angle with the X axis, which is the angle of their inclination to the horizontal. When both co-ordinate axis have their scales equal, the numeric value of the tangent of the angle of inclination of a straight line to the horizontal is called its *slope*. When, however, the scales of the two axes are not equal the slope is the ratio of the number of units in the ordinate of a point on the line to the number of units in the abscissa of the same point. In Fig. 47, for instance the slope of $OA = \frac{AB}{OB} = \frac{20}{20} = 1$; and the slope of $OC = \frac{CB}{OB} = \frac{10}{20} = 0.5$.

To identify the equation $I = \frac{E}{R}$ with the general equation $y = a + bx$, we make $y = I$, $x = E$, $b = \frac{1}{R}$ and $a =$ zero. a is zero because the slope passes through the origin.

Very often the voltage is kept constant, as for instance at 24 volts. We would

in such a case write Ohm's law as $R = \frac{E}{I}$ and to identify this equation with the general equation $y = a + bx$, we make $y = R$, $x = \frac{1}{I}$, $b = E$ and $a =$ zero. Then for $I = 1$ ampere, x would be $= 1$ and $y = 24 \times 1 = 24$. For $I = 0.5$ ampere x would be $= 2$ and $y = 24 \times 2 = 48$. For $I = 0.1$ ampere x would be $= 10$ and $y = 24 \times 10 = 240$. These values are plotted in Fig. 48. The scales in this figure are chosen unequal to condense the information into smaller space.

For a graphical representation of two simultaneous equations it must be remembered that a straight line is determined by two points, and that two straight lines intersect in a single point, as long as they are not parallel to each other. Therefore, if we plot two points for each of the given equations and draw the two corresponding straight lines, their intersection will give a point having an abscissa and an ordinate, the values of which, when substituted in the two given equations will satisfy them.

It must be furthermore kept in mind what we have learned about intercepts; namely, that a Y intercept means that the line cuts the Y axis at the point where $x = o$; this gives a means to determine a value of y from each of the two given equations by putting $x = o$. In the same manner the value of x is determined by substituting $y = o$ in each of the two given equations. To more clearly show how this is done we take as an example the two equations we have treated before algebraically; namely, $5x + 7y = 31$ and $2x + 3y = 13$. Substituting in both equations o for the y term we obtain $5x + o = 31$ and $2x + o = 13$ or $5x = 31$ and $2x = 13$ or $x = \frac{31}{5} = 6.2$ and $x = \frac{13}{2} = 6.5$ respectively. Then we substitute o for x, obtaining $7y = 31$ and $3y = 13$ or $y = 4.428$ and 4.333, respectively. If we now draw on cross section paper having equal scales for the co-ordinates a line through the points 4.428 on the Y axis and 6.2 on the X axis, and another line through the points 4.333 on the Y axis and 6.5 on the X axis, we will find that the two lines intersect at a point having the co-ordinates $x = 2$ and $y = 3$.

It will be noticed from Fig. 49, wherein these two lines are plotted, that they run very close together so that it is difficult to locate exactly their intersection. Therefore we will in a second example substitute the equation $5x - 3y = 2$ for the second equation. Putting again $x = o$ in the two equations, and also $y = o$ as before, we can tabulate the corresponding values of x and y as follows:

x	y
6.2	4.428
0.4	− 0.666

With this information we plot the values $x = 0.4$ and $y = -0.666$ and connect the two points by a straight line.

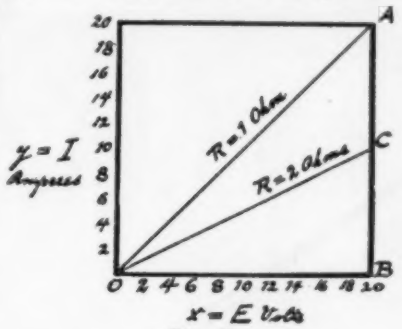

Fig. 47

The extension of this line will intersect with the line drawn before through the points $x = 6.2$ and $y = 4.428$ at a point having the co-ordinates $x = 2.14$ and $y = 2.9$. To check the figures we solve

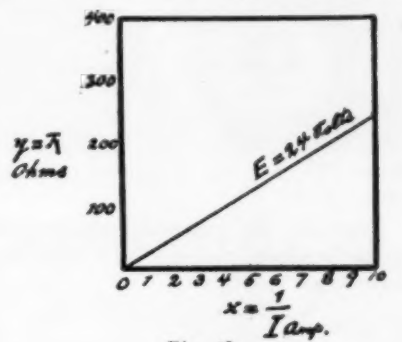

Fig. 48

the equations algebraically by subtracting them from each other, thus:

$$\begin{array}{r} 5x + 7y = 31 \\ 5x - 3y = \ 2 \\ \hline 10y = 29 \\ y = 2.9 \end{array}$$

This value of y we substitute in equation $5x - 3y = 2$, obtaining $5x - 8.7 = 2$ and $x = \frac{10.7}{5} = 2.14$.

We will not occupy ourselves with further discussion of this subject, but take up the equations of the second degree, more familiarly known as quadratic equations.

44. Quadratic Equation

Quadratic equations are of two kinds, pure quadratic equations and mixed quadratic equations. Pure quadratic equations contain the variable x in the second power only, while in mixed quadratic equations the independent variable x appears also in the first power. The simplest form of a pure quadratic equation is $x^2 = a$. We have learned that if $x^2 = a$, x is the square root of a, that is, $x = \sqrt{a}$; therefore $x \times x = \sqrt{a} \times \sqrt{a} = a$. As an example $x^2 = 25 = 5 \times 5 = x \times x$ whence $x = \sqrt{25} = 5$. We have also learned that not only $5 \times 5 = 25$, but also $(-5) \times (-5) = 25$; therefore it is also correct to write $x = \sqrt{25} = -5$. We must therefore, to be exact, state that $\sqrt{25} = \pm 5$. In general we state: if $x^2 = a$, there will be two values for x, namely, $+\sqrt{a}$ and $-\sqrt{a}$, which is written briefly as $x = \pm\sqrt{a}$. The two values are always of opposite sign, thus $(+\sqrt{a}) \times (+\sqrt{a}) = a$ and $(-\sqrt{a}) \times (-\sqrt{a}) = a$ or $(+\sqrt{a})^2 = (-\sqrt{a})^2 = a$. If $x^2 = a^2$, then $x = \pm a$. It is also $\sqrt{a^2} = \pm a$. If $x^2 = (a + b)^2 = a^2 + 2ab + b^2$, then $x = \pm (a + b) = \pm\sqrt{a^2 + 2ab + b^2}$, and if $x^2 = (a - b)^2 = a^2 - 2ab + b^2$, then $x = \pm (a - b) = \pm\sqrt{a^2 - 2ab + b^2}$. The equation $a^2 + 2ab + b^2 = (a + b)^2$ is the foundation for the operation of extracting square roots. In section twelve on "Involution and Evolution" it was shown how $\sqrt{3}$ is extracted and the process of operation was given. Here the reason will be shown why that process was followed. The most illustrative way to do this is as follows:

$$\sqrt{a^2 + 2ab + b^2} = a + b.$$

$$\begin{array}{r|l} a^2 & \\ \hline 2a & 2ab \\ & 2ab \\ \hline & b^2 \\ & b^2 \\ \hline & 0 \end{array}$$

Example:

$$\sqrt{529} = 20 + 3 = 23$$

$$\begin{array}{r|l} a^2 = 400 & \\ \hline 2a = 40 & 129 \\ 2ab = 120 & \\ \hline & 9 \\ b^2 = 9 & \\ \hline & 0 \end{array}$$

The above with the explanation given in section twelve will suffice to give to the reader the fundamental idea of extracting square roots. We repeat that in practical work tables are used or logarithms. The latter will be explained before long.

To solve mixed quadratic equations all terms containing x^2 are collected together, also all terms with x and finally all terms without x; then the general form of a quadratic equation may be written as $ax^2 + bx + c = o$. Such an equation is solved by completing the square, as follows: Multiply the general equation by a, obtaining $(ax)^2 + abx + ac = o$. Adding $\left(\frac{b}{2}\right)^2$ to both sides gives $(ax)^2 + abx + \left(\frac{b}{2}\right)^2 = \left(\frac{b}{2}\right)^2 - ac$ or $\left(ax + \frac{b}{2}\right)^2 = \frac{b^2 - 4ac}{4}$ as $\left(\frac{b}{2}\right)^2 = \frac{b^2}{4}$ and $\frac{b^2}{4} - ac = \frac{b^2 - 4ac}{4}$.

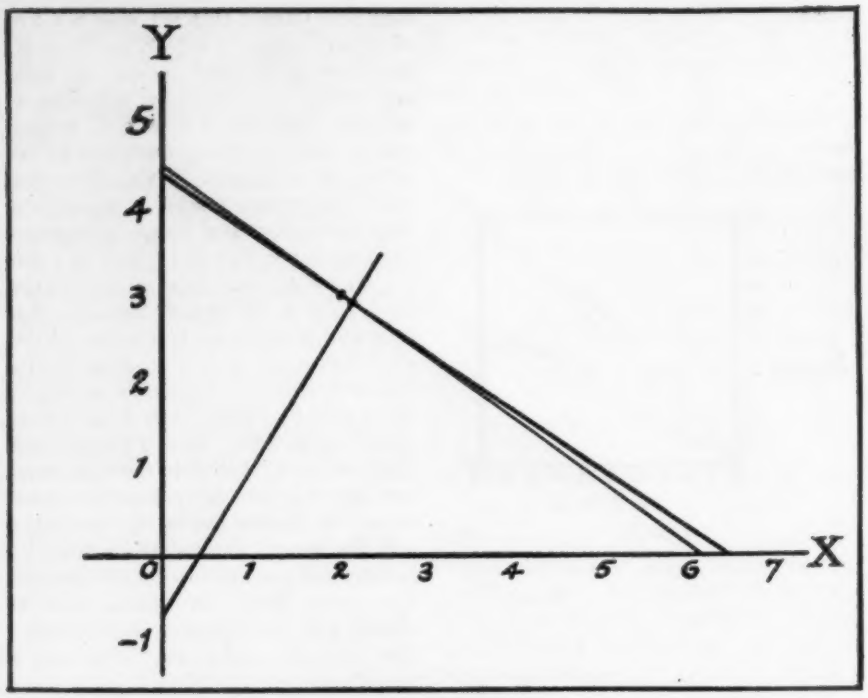

Fig. 49

For sake of simplicity designate the expression $\frac{b^2-4ac}{4}$ by D; then we have also

$$\left(ax+\frac{b}{2}\right)^2=D.$$

The solution of the quadratic equation depends on the value of D. If $D=0$, $\left(ax+\frac{b}{2}\right)^2=0$, and also $ax+\frac{b}{2}=0$, which will be recognized as an equation of the first degree.

D, which in mathematics is called the "Discriminant," may be a positive quantity, then

$$\left(ax+\frac{2}{b}\right)^2=+D$$

$$\text{and } ax+\frac{b}{2}=\pm\sqrt{D}$$

$$-\frac{b}{2}\pm\sqrt{D}.$$

$$\text{whence } x=\frac{}{a}.$$

Two real values of x are obtained. But if D is a negative quantity, its value may be written as $-K^2$, where K is a positive real quantity. Reverting for a minute to the $\sqrt{25}$, we have seen that $\sqrt{25}=\pm 5$; but we do not know of a number, which, when multiplied by itself, will give $\sqrt{-25}$; therefore $\sqrt{-25}$ is something impossible, it may be called *imaginary*. Only a couple of centuries ago the mathematicians began to examine such imaginary quantities; so they put $\sqrt{-25}=\sqrt{25}\times\sqrt{-1}$ and called the quantity $+\sqrt{-1}$ the *imaginary unit*. They gave to the imaginary unit the designation "i." But in the science of electricity the designation "i" is frequently used to denote the instantaneous value of an alternating current, therefore it was found expedient to introduce the letter "j" for the imaginary unit in place of "i."

The quadratic equation containing D as a negative quantity may now be written as:

$$\left(ax+\frac{b}{2}\right)^2=-K^2$$

whence

$$ax+\frac{b}{2}=\pm\sqrt{-K^2}=\pm K\times\sqrt{-1}=\pm jK,$$

which gives the value of

$$x=-\frac{b}{2a}\pm j\frac{K}{a}.$$

As $-\frac{b}{2a}$ and $\frac{K}{a}$ are both real quantities, the value of x can be written in a more simple form, namely $x=A\pm jB$. This is the general form of a *Complex Quantity*. Complex quantities are a combination of imaginary quantities and real quantities, and play a great role in alternating current work, where we will have a chance to discuss them.

For numerical calculations the value of x is as follows:

$$x=-\frac{b}{2a}\pm\sqrt{\frac{b^2-4ac}{4}}\text{ or }=$$

$$\frac{-b\pm\sqrt{b^2+4ac}}{2a}$$

As an example we may take the equation $5x^2-24x+16=0$. Substituting in the above equation for x the values 5 for a, -24 for b and 16 for c we obtain

$$x=\frac{24\pm\sqrt{(-24)^2-4\times5\times16}}{10}=$$

$$\frac{24\pm\sqrt{256}}{10}=\frac{24\pm16}{10};$$ thus the two roots of the equation $5x^2-24x+16=0$ are $\frac{24+16}{10}=4$ and $\frac{24-16}{10}=\frac{8}{10}$ or $\frac{4}{5}$.

45. Graphical Representation of Quadratic Equations

The form of the graph of quadratic equations is non-linear. There are a great number of non-linear curves used in mathematics and physics to plot and examine the results of observations and experiments and formulate therefrom expressions which embody the laws observed in the experiments, or also to serve as a record of transactions and experiences. The plotting of facts in curves, linear as well as non-linear, is of inestimable assistance in any branch of applied sciences including telephony. Here we are interested only in illustrating briefly the mathematical features of such curves. In physical discussions we will meet with their practical application. The curves serving as records only are not so much interwoven with mathematics, but the curves used for interpreting physical phenomena and to devising formulas to express the laws underlying the actions of such phenomena, possess a higher mathematical character and are somewhat difficult to be grasped by the practical telephone man. Therefore we will refrain to go too deep into the subject of non-linear curves but give enough to enable the reader to form a general idea of the principal families of such curves.

Not all the linear and non-linear graphs have a mathematical reason for their existence, many have nothing at all in common with mathematics but give a vivid picture of some process or phenomenon which, however, is purely illustrative, and void of any mathematical meaning; others again take on some of the mathematical character although they cannot be expressed by an equation, but they serve to analyze the process of which they are representative and permit to form a conception of the performance of it whether it is good, bad or indifferent; they furthermore permit of drawing conclusions whether the process needs correcting, and if so, they point out the direction in which such corrections should be made. We will present two examples from telephony which show how such graphs are useful for the representation and analysis of problems and still are not mathematical.

In a very long telephone line the energy supplied to the line at the transmitter end decreases in proportion to the length of line, technically speaking, it

Pathfinders

An Advertisement of
the American Telephone and Telegraph Company

CHRISTOPHER COLUMBUS discovered America, thus adding a new world to the old. Alexander Graham Bell discovered the telephone, giving the nations of the earth a new means of communication. Each ventured into the unknown and blazed the way for those who came after him.

The creating of a nation-wide telephone service, like the developing of a new world, opened new fields for the pathfinder and the pioneer. The telephone, as the modern American knows it, has been made possible by the doing of a multitude of things in the realms of research, engineering and business administration. Its continued advancement requires constant effort in working upon a never-ending succession of seemingly unsolvable problems.

Because it leads the way in finding new pathways for telephone development, the Bell System is able to provide America with a nation-wide service that sets the standard for the world.

becomes "attenuated," and would die out if it would not be given a new lease of life by the means of "repeaters." A repeater increases the energy or power, and lifts it up, so to speak, to a higher "level," from which it slides down again until it reaches the next repeater, where it is boosted up again until it finally reaches the end of the line with enough power left to operate the receiver.

In Fig. 50 a diagram is given of the power levels of the long distance line from San Francisco to New York. This

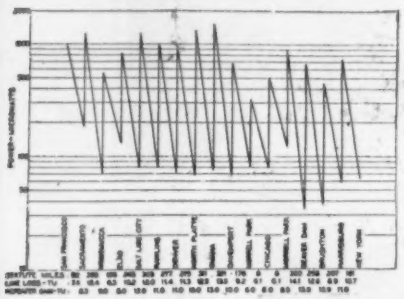

Fig. 50—Power levels of San Francisco-New York connection at 1000 Cycles, power of 1000 microwatts is applied at San Francisco

diagram is composed of straight lines, but they cannot be interpreted as equations. The horizontal scales are of the same description as the ordinary scales along the axis of abscissae, but the vertical scale, though systematically arranged, is not evenly divided into units like the scales along the axis of ordinates met with before. Along the horizontal axis the names of the places are inserted where repeaters are located. Besides there are three scales: one which gives the statute miles between the consecutive repeaters; the second one gives the line losses in TU (transmission units), that is, the number of transmission units lost between each pair of consecutive repeaters; and the third the repeater gains in TU, that is, the number of transmission units gained at each repeater station by the repeater lifting the energy to a higher power level. Along the vertical axis is marked the power in microwatts (one microwatt equals one thousandth of a watt).

The curve simply states that a power input of 1,000 microwatts at San Francisco is attenuated 7.4 TU until it reaches Sacramento, where the first repeater is located, which increases the power by 83 TU and lifts it to a level above the San Francisco level, as the figure plainly shows. Then the power is attenuated again by 12.4 TU by the time it reaches Winnemucca, where the second repeater is located, which brings the power up again to a higher level, and so on, until finally the power reaching New York is about 60 microwatts, sufficient for operating the receiver. In this diagram no equation is represented nor any physical law expressed, the diagram simply shows graphically how the energy applied to the line loses and gains alternately on its way to New York.

We now will present a curve which, though having no relation to mathematics, is plotted with reference to regular co-ordinate axes and approaches more to the mathematical character of non-linear curves. The curve in Fig. 51 represents the over-all transmission—frequency characteristic of a 1,400 mile non-loaded 165 mil circuit.

The overcoming of attenuation losses in a line by the use of repeaters is not sufficient to secure good transmission, the speech received at the distant end of the line must also be unimpaired, that is, it must not be distorted. It will be remembered that in the discussion of the Problem of Telephone Physics it was stated in section sixteen that "telephone transmission is a problem of wave propagation and that all electromagnetic waves are alternating currents," and in section thirteen that "the human ear can perceive tones having a range of from 16 to 40,-

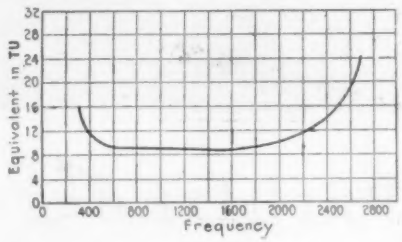

Fig. 51—Over-all transmission—Frequency characteristic of 1400-mi. non-loaded 165-mil circuit

000 vibrations per second, which are the extreme limits." But the speech vibrations transmitted over a line reach only from somewhere around 200 to 2,000 vibrations per second, or to state it in the usual technical terms, the frequencies in telephone transmission lie between 200 and 2,000 cycles per second. The frequencies of most importance have a still narrower band, they range from about 600 to 1,200.

Just as much as attenuation has to be kept down in order to obtain good transmission care must be taken to avoid distortion of speech. Distortion results when a too narrow band of frequencies is transmitted, or when the volume of transmission of part of the frequencies within the range transmitted is materially different from that of another part of the frequency range. Therefore all frequencies must be transmitted so that as the attenuation increases with the frequency, repeater gains increase practically at the same ratio, so that the result of the combination of line and repeaters gives a transmission-frequency characteristic that is substantially flat. In Fig. 51 a curve is plotted with the frequencies as abscissae and attenuation equivalents in TU as ordinates. As will be seen the frequency part between 500 and 1,600 cycles per second, which, as stated above, contains the most important speech-transmission frequencies is flat, indicating that the transmission obtained over the range of frequencies important in speech is practically uniform. We now proceed to give a brief account of the most important graphs of quadratic equa-

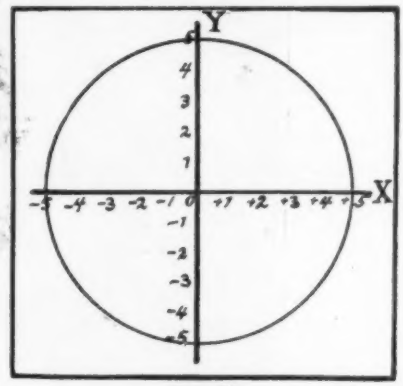

Fig. 52

tions. As first illustration we chose the equation $x^2+y^2=25$. We must keep in mind that the co-ordinates of every point on the graph must satisfy the equation of the graph and that every point whose co-ordinates satisfy the equation must lie on the graph. In mathematical language, the graph is the *locus* of points whose co-ordinates satisfy the equation.

We first transform above given equation thus: $y^2=25-x^2=5^2-x^2$, whence $y=\pm\sqrt{25-x^2}$. By giving x the values 0, 1, 2, 3, 4, 5, the corresponding values of y are determined and tabulated thus:

x	y
0	$\pm\sqrt{25}=\pm 5$
+1	$\pm\sqrt{24}=\pm 4.8$
+2	$\pm\sqrt{21}=\pm 4.5$
+3	$\pm\sqrt{16}=\pm 4$
+4	$\pm\sqrt{9}=\pm 3$
+5	$\pm\sqrt{0}=0$

As will be seen there are two values for y for each positive value of x. If the same calculation would be performed by giving x negative values from 0 to −5, the same values for y would be obtained as in the table. Therefore, the values of y can be plotted in a system of co-ordinate axes beginning at the origin, to the right for $x=0, +1, +2$, etc., and to the left for $x=0, -1, -2$, etc. Drawing a curve through all the points thus obtained it will be seen from Fig. 52, that this curve is a circle. The *equation of a circle*, with its center at the origin and its radius equal to r, therefore, has the general form $x^2+y^2=r^2$.

If the center of the circle would not lie in the origin of the co-ordinate system but if its co-ordinates would be a and b, the equation of the circle would be $(x-a)^2+(y-b)^2=r^2$; and when the origin of the co-ordinate system lies in the circumference of the circle and the center in the X axis (that means $a=r$ and $b=o$) the equation of the circle

would be $x^2 - 2rx + y^2 = o$. So much for the circle.

As our next example we take the equation $y - x^2 = o$, which transformed gives $y = x^2$. Giving again x the values 0, 1, 2, 3, 4, 5 and 0, −1, −2, −3, −4, −5, we obtain the corresponding values of y as 0, 1, 4, 9, 16, 25 and 0, +1, +4, +9, +16, +25. These values are plotted in Fig. 53. The curve so obtained is a *"parabola."* The parabola has no center.

Given the equation $9x^2 + 25y^2 = 225$. To find the graph of this equation, transpose, obtaining $y^2 = \frac{225 - 9x^2}{25}$, whence $y = \pm \frac{\sqrt{225 - 9x^2}}{5}$. Giving x again the values from 0 to +5 and from 0 to −5, the following table is obtained:

x	y
0	$\pm \frac{\sqrt{225}}{5} = \pm \frac{15}{5} = \pm 3$
1	$\pm \frac{\sqrt{216}}{5} = \pm \frac{14.6}{5} = \pm 2.9$
2	$\pm \frac{\sqrt{189}}{5} = \pm \frac{13.5}{5} = \pm 2.7$
3	$\pm \frac{\sqrt{144}}{5} = \pm \frac{12}{5} = \pm 2.4$
4	$\pm \frac{\sqrt{81}}{5} = \pm \frac{9}{5} = \pm 1.8$
5	$\pm \sqrt{0} = 0$

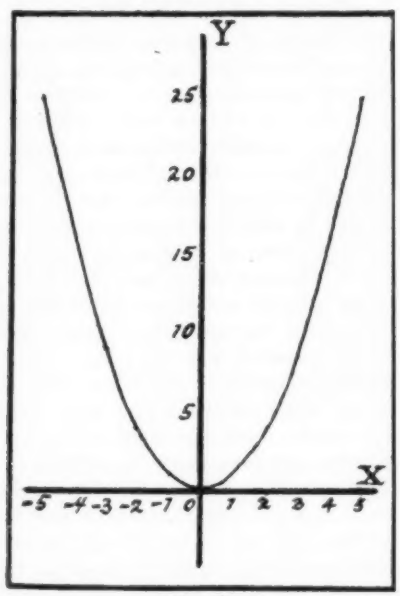

Fig. 53

Plotting these values in a system of co-ordinates as shown in Fig. 54 a curve is obtained, which is an "Ellipse." The general equation of an ellipse is written as $ax^2 + by^2 = c$.

Taking as our final example the equation $9x^2 - 4y^2 = 36$, we obtain by transposition $y^2 = \frac{9x^2 - 36}{4}$ and $y = \pm \sqrt{\frac{9x^2 - 36}{4}} = \pm \sqrt{\frac{9(x^2 - 4)}{4}} = \pm \frac{3}{2}\sqrt{x^2 - 4}$

Giving x again the values from 0 to +5 and 0 to −5 the following table results:

x	y
0	$\pm \frac{3}{2}\sqrt{-4}$; this is an imaginary value.
1	$\pm \frac{3}{2}\sqrt{-3}$; this is also an imaginary value.
2	$\pm \frac{3}{2}\sqrt{0} = 0$
3	$\pm \frac{3}{2}\sqrt{5} = \pm \frac{3}{2} \times 2.236 = \pm 3.354$
4	$\pm \frac{3}{2}\sqrt{12} = \pm \frac{3}{2} \times 3.464 = \pm 5.196$
5	$\pm \frac{3}{2}\sqrt{21} = \pm \frac{3}{2} \times 4.58 = \pm 6.87$
6	$\pm \frac{3}{2}\sqrt{32} = \pm \frac{3}{2} \times 5.657 = \pm 8.485$

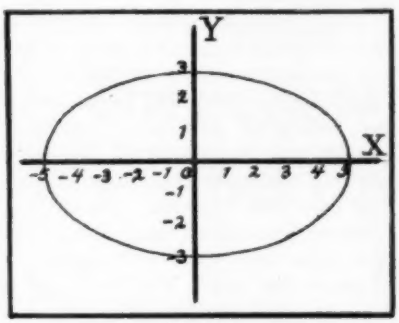

Fig. 54

The imaginary value we can not plot. The first point is $y = o$ for $x = 2$ and also $y = o$ for $x = -2$. Next ± 3.354 for $x = +3$ and -3 respectively, and so on. It will be noticed in Fig. 55 that two separate branches are obtained, both branches being alike but reversed. This curve is a *"hyperbola,"* and its general equation is $ax^2 - by^2 = c$, a, b and c are positive numbers, in this equation as well as in the other equations just developed.

This will be a sufficiency of examples.

At the beginning of this discussion we have laid stress upon the usefulness of

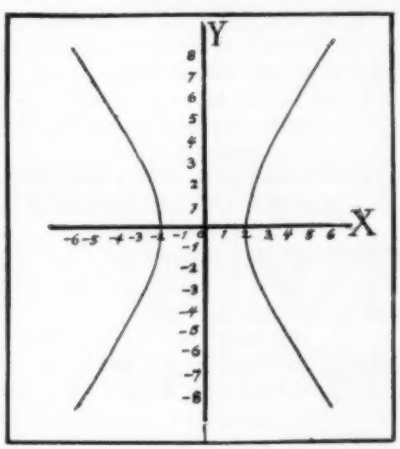

Fig. 55

curves to demonstrate clearer than would otherwise be possible, a series of observations or data from experience. Such data and observations may be of scientific or commercial origin; they may have been collected in the laboratory or in the business office; their value in sizeing up results and drawing valuable conclusions therefrom can not be denied. When speaking of curves in the general way we also include straight lines such as represent equations of the first degree. Of particular importance is the "slope," be it of a straight line or of a curve. The slope of a straight line was defined as the numeric value of the tangent of the angle of inclination to the horizontal. A little thinking will show that the value of y being the dependent variable, increases, not as x increases, but at a constant rate relative to the increase of x; this *rate* is the slope of the line. There is a symbol for this slope or rate of increase, namely $\frac{dy}{dx}$, which we have encountered at an earlier occasion when we spoke of the time rate of change in the magnetic flux (section 30). The slope and its symbol will occur again and again in mathematical discussions and deductions.

Curves proper have also slopes. Take for example the curve A B C D E in Fig. 56, which represents an arbitrary curve. In this curve there is positive slope in the parts A B and C D, where y increases as x increases, and negative slope in the parts B C and D E where y decreases as x increases. There are two points on the curve, namely B and D, where y reaches its highest value before going down again; these points are called

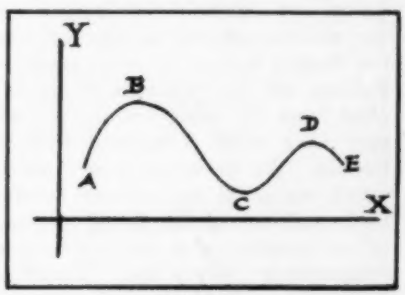

Fig. 56

points of maximum; at the point C the curve has its lowest value before ascending again, this is the *point of minimum.*

A further discussion of slopes would lead into advanced mathematics.

W. E. Harkness Is New Bell Long Lines Official

New York City.—W. E. Harkness, formerly assistant vice president of the A. T. and T. Co., in charge of broadcasting, has been made manager of the auxiliary service of the Bell's Long Lines department. In this connection he will have charge of telephotographs, wire service used in connection with broadcasting, and other auxiliary services.

LINE AND DESK

CALL FOR HELP ON A NOISY SWITCHBOARD

A subscriber in a tropical country writes us asking for light on a type of trouble which he is having. He says: "We have a 3-position magneto switchboard. Many times one position becomes very noisy; that is, ringing in other positions can be heard when the operator's listening key is thrown open. Has the operator's coil anything to do with it? We notice that the ringing noises disappear whenever we boil in paraffine the operator's coil in the noisy position.

We never have observed trouble that occurs in just the way our querist describes. Frequently, ringing noise is observed in the operator's set when ringing on the same positions. This usually is due to low insulation somewhere in the position. Metal filings or burned bushing between springs of ringing and listening keys may be a source of trouble of this sort. The fact that the noise disappears when the operator's coil is boiled in paraffine suggests that low insulation, probably due to dampness, is the cause but we are not able to determine just why one position should be affected when the ringing is done on other positions. Perhaps all the transmitters are supplied from the same battery and this may have some connection with the trouble. We have had many queries which we could not answer satisfactorily and have always found some one of our readers who could give some enlightening information. Therefore, we are passing on this query to our readers with the cry: "Help! Help!"

PAINT DID NOT STOP CROSS TALK BUGS

C. E. Gardner, whose recollections of early days of telephony in Michigan are unsurpassed tells in a recent number of "The Mouthpiece" of another attempt to eliminate cross talk:

"Remember the story about the experiment with barbed wire for the prevention of cross-talk, published in the February number of "The Mouthpiece?" Well, here is another experiment.

"One day, more than a quarter century ago, the Research department of the Saginaw exchange, the manager, instructed us to string a No. 12 iron wire from the office to the sawmill of the Hamilton-McClure company, located on the west side of Saginaw river about six or seven miles north from the central office.

"You are to carefully paint this wire with a heavy coat of white paint which, if properly done, will prevent all interruption to service from cross-talk," he said, and he furnished us with a gallon of paint and a couple of three-inch brushes.

"If I remember rightly, the first day we succeeded in getting paint on about six spans of wire and all tied in. With nearly seven miles still to be covered, we wondered how many months it would take to complete. So we organized an engineering department of our own and invented a piece of galvanized iron eavestrough, about eight feet long with each end closed. We dumped the paint into that and laid out one span of wire. Two of us carried the invention from pope to pole, immersing the wire in the paint as we went along, and by golly, it worked—not so bad.

"About a week later we had all wire up, the instrument connected and all ready for the research man. He sat in his office and had a connection put up.

"Holy smoke! When he discovered that there was not the least bit of improvement, the air went blue. He accused us of every crime but murder. We had not done our job in accordance with specifications. In fact, we were the d——t bunch of numbskulls that he had ever come in contact with.

"I wonder if General Carty ever heard of this experiment. Some day I'll tell of one more trial that may interest some of the younger bunch."

INFORMATION ON LESSENING RADIO INTERFERENCE IS NEEDED

Willard D. Forsyth of the Saint James (Minn.) Telephone Co., writes us as follows:

"In this day of radio, there are many questions and requests to help eliminate the noise caused by motors, electrical apparatus motion picture machines, etc. Unfortunately, it is not possible to remedy all of the disturbances but a good many of the noises could be eliminated or reduced at their source. Is there any book published that would give information of this kind showing diagrams and just how to take care of this kind of trouble. As a rule, a telephone company has some condensers, coils and other equipment of this kind in its store room that could be used for eliminating disturbances, if they knew just where to place them, and how."

"Nearly every telephone man receives requests to aid in the elimination of radio interference and finds himself handicapped by the lack of information on the subject. We have been able to work out our problems of interference from ringing machines fairly well but are still puzzled by other appliances. We are publishing Mr. Forsyth's letter in hope that some of our readers may have suggestions to offer."

COPPER CLAD DROP WIRE STANDS SEVERE SERVICE

I doubt if everyone realizes just how serviceable copper clad No. 17 twisted pair drop wire is despite the fact that its virtues were voiced in a capable manner by P. Kerr Higgins in his recent article, "Tells of Happy Medium Wire." I had occasion recently to install a telephone on board a ship lying in Manila Bay, not far from where Dewey sunk the Spanish fleet, and at a distance of about 900 feet from the pier where our nearest cable terminal was located. I laid a twisted pair drop wire for this distance through the water. A weight was tied to the wire with a tie similar to the regulation tie on a knob and sunk near the pier, another weight was tied on and sunk near the bow of the ship, a number of feet of slack were run out and then taken up over the rail and back aft to a common battery telephone. This circuit worked perfectly for eight days and on a test before removing from the water showed the same insulation that it did when first submerged. To my knowledge this is the first time that this type of wire ever has been exposed to salt water and furnished service to a common battery telephone.

On another occasion, while making an inspection of a small exchange in the Province of Pampanga, a working telephone was located about one-quarter mile from the nearest cable terminal but no connecting line was

visible. Investigation developed the fact that a Filipino lineman conceived the brilliant idea of burying a No. 17 twisted pair drop wire in the ground to avoid setting poles. This line had given perfect service for over a year without a single case of trouble. The wire was dug up in several places for inspection and although the insulation had indications of deterioration, it still was effective. This type of wire no doubt has great possibilities for restoring service temporarily in flooded areas after storms. My experience proves conclusively I believe, that wire which will stand up under tests as severe as these will furnish service under ordinary requirements almost indefinitely without trouble.—Ray Blain.

CARBON MONOXIDE — OUR DEADLY ENEMY

Carbon monoxide is a deadly, though colorless and oderless gas exhausted by gasoline and internal combustion engines. Therefore, the air in a closed or partly closed room or garage may seem perfectly pure and yet may contain enough carbon monoxide to prove fatal.

This gas is formed by burning almost any kind of fuel without sufficient oxygen. A small percentage in the air will cause headaches, then unconsciousness, then death. The blood has a great affinity for carbon monoxide, and absorbs it from the lungs instead of the oxygen which is needed to sustain life.

An automobile engine running in an ordinary small garage with doors and windows closed or partly closed will produce enough carbon monoxide in a few minutes to cause death, and the person or persons in such a garage are generally overcome without warning.

The only safeguard is **never to run a gasoline engine unless the garage doors and windows are wide open.** If your engine is running and you feel a headache or faintness, even if you think the ventilation is all right, go at once into the open air.

Should you find anyone unconscious in a garage or room, drag him at once to the open air if possible. If you cannot do this, open the doors and windows wide and send for a physician. If the victim has stopped breathinfi, start artificial respiration by the prone pressure method. Send someone to call the electric light company or gas company, if they are equipped with carbon dioxide-oxygen inhalents.

If you do not know how to start artificial respiration, get someone to teach you at once, for you never can tell when it is going to be of great benefit to your family or friends.—H. A. Mott, in "Bell Telephone News."

"BUGS I HAVE SHOT."—THE SNEAKY FLU GERM.

During the first flu epidemic at Wallace, Wash., in 1918, a case of trouble was investigated by one of our men who found the mouthpiece of the instrument was plugged with a piece of cotton, saturated with a disinfectant. Upon asking the elderly woman subscriber why she had done this, our man was told that she "wanted to protect herself from the flu and didn't want any germs crawling into her house through the hole in the telephone wires."—A. F. Coonradt.

A. B. Clark Goes to England for Gary Interests

Muskegon, Mich.—A. B. Clark, supt. of plant and construction for the United Home Telephone Co., and connected with its predecessors for 22 years, has resigned to go to England, where he will join the staff of the Associated T. and T. Co., a Gary property.

Delaware, O.—W. C. Diven has been named general manager of the Citizens Telephone Co., succeeding the late George H. Carter.

A test "lab" that forecasts your cord performance

WHAT you may confidently expect in service from a switchboard or telephone cord is forecast with amazing accuracy in the Runzel-Lenz testing laboratories. Here each lot of raw material is carefully selected and tested for its particular work in the finished cord. There is this complete watchfulness in each detail of testing and manufacture, so we can make to you the emphatic statement that Runzel-Lenz cords will out-perform any other cord, and have our laboratory's story as the firm basis for our promise.

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BIRMINGHAM Brown-Marx Bldg.
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SALT LAKE CITY
Walker Bank Bldg

UNITED STATES STEEL PRODUCTS COMPANY, San Francisco, Los Angeles, Portland, Seattle

How Telephone Financiers Lay Their Foundations

By HARRY C. DODGE

Reputable securities houses in financing Independent telephone issues are following today a plan of procedure that they have every confidence will result in bettering the market for the securities and having a bright reflection in improving the management, from a financial point of view, of Independent companies that have had so many urgent operating duties to attend to that they have neglected the condition of their prosperty insofar as it concerns its financing possibilities.

A number of the investment houses that have been active in Independent financing have been striving toward standardized practice, and some of their conclusions are presented here for the study and comment of Independent telephone men.

In formulating a program for financing Independent telephone companies on a basis whereby it is expedient to underwrite a bond issue, certain information respecting the following matters must be in the hands of the prospective underwriters of the issue.

Information in the premises regarding the following matters among others should be forth-coming.

The total cost of the property should not exceed 10 times to 12 times the amount of the net earnings after operating expense, taxes and depreciation.

As a general proposition, class "A" and "B" situations on an overall of 8% which is 12½ times net earnings after depreciation may be considered justifiable and desirable from the purchase viewpoint due to the fact that the Communities served are substantial in character and subject to very good growth in the near future.

With the above as a yard stick, it would seem as though the situation of small companies (class "C" companies and smaller) would probably be particularly desirable only in case the average price of the property were less than 2½ times the net earnings after depreciation, even though such price might be as low as 50% of the present depreciated value of the properties.

In considering profits, some allowance should be made for the likelihood of substantial savings in overhead expense if additional properties were merged with it, together with saving in operating expenses due to some revision of the physical property.

In the above discussion it is taken for granted that approximately 4½% of fixed assets as carried on the company balance sheet (assuming this balance sheet reflects substantially the valuation of the property for rate-make purposes) is an adequate depreciation figure to be included in the operating ratio.

With the operating ratio defined as above, it is generally considered by bankers that a satisfactory earning ratio would be as follows:

Bond interest should be earned historically between 2½ and 3 times before depreciation and from 1¾ to 2 times after depreciation.

Bankers should have the history of the companies to be financed, such information to include number of subscribers, city and rural, rates for different classes of service rendered, earning statement showing amount of depreciation charge (this depreciation should be at least 4% of cost of plant.)

The balance sheet in this plant account should show original cost of plant plus accruals.

Statement should show amount expended for improvements and betterment.

Type and capacity of switchboards and description of wiring system.

Description of toll lines and revenues received therefrom.

Itemized list of all indebtedness.

Franchise provisions.

Standardized Financing of Tel. Companies.

Bond issues representing reliable investments are originated by conservative bankers according to approved procedure herein described, to which much publicity has been given. Discriminating investors realize that it is advisable to deal with a concern using these standardized methods.

Reputable investment security houses depend for the success of their selling efforts upon plain statements of pertinent facts regarding offered issues of bonds.

The Circular.

The bond circular states plainly the following facts; the name of the company making the loan, the amount of bonds to be sold, the price at which they are being offered, the date on which they mature, and their yield. It describes the territory served by the issuing corporation, a public utility; the security for the bonds is described in detail. Earnings for a term of years are given, and the past year's earnings are given exactly; and sets forth a comparison of the net earnings with the annual interest requirements on the company's bonded debt, including the present issue. The management of the company is described.

The preliminary negotiations for the purchase of an issue generally require frequent and extended conferences, engineering reports, audits, legal services, and many other formalities. There is customarily a preliminary presentation by the applicant to the bond house with a discussion of the business in detail and the character of the loan desired. If this preliminary presentation is satisfactory and seems to warrant further investigation, a preliminary contract is drawn, giving the bond house an option for a certain length of time during which it may go more carefully into the matter, including examinations regarding the credit, contract, management, financial condition of the prospective borrower. If all of these matters are satisfactory to this point, the bond house will conduct a final examination of the Company, including ownership of the corporation, credit, location of its properties, territory in which it operates, economic conditions therein, competition, and will make an analysis of its earnings, capitalization and the balance sheet. This is carried out with much detail and generally at considerable expense.

Engineering Reports.

Engineering experts will make an appraisal of the property, estimate its replacement value and give an option on such intangible values as franchises and good will. They will figure on the rate of depreciation of the physical property, and the percentage of gross earnings necessary to maintain the property in the most efficient operating condition. They will see whether the property is economically constructed, whether strategically located, as regards efficiency and economy of distribution. They will ascertain as to whether prices paid for the Company's services are sufficient to pay operat-

ing expenses and fixed charges and still leave a fair return for the stockholders. Finally, they will give an opinion as to what extent money will be required for working capital, improvements and extension, etc.

Legal Matters.

Legal experts will look into the corporation's charter and by-laws and decide whether they are drawn in accordance with the laws precribed by the state in which the company is incorporated. They will investigate the company's franchises, titles to its properties, its contracts, leases and agreements, will go over very carefully the indenture covering the proposed issue of bonds.

Audit.

An audit of the company's books will be made, statements of comparative earnings, comparative balance sheets, comparative charges to maintenance and depreciation over a period of years will be furnished, an analysis of accounts will be made in detail, and a summary and statement rendered as to the financial position of the company.

Financial Structure.

Finally a financial plan is prepared by the bond house, based on the various reports and audits which have been turned in, and if the decision of the buying department of the bond house is favorable, the next consideration has to do with the manner and form in which credit may best be extended and what safeguards are necessary in order to afford necessary and adequate protection to the rights of the investor.

Final Analysis.

Before the deal is closed the banker must consider the importance of market conditions and prices; will the retail price of the issue be such as to attract investors so that the bonds may be readily sold? Is the financing of such a type that the borrowing corporation will not be hampered or restricted in a way which might handicap it in its operations? In the final analysis, if everything is satisfactory, a final contract is signed by the corporation and the banking house, and the deal then passes into the hands of the sales department of the banking house. The reliable banker who underwrites a bond issue appreciates that the interests of the corporation, the banker and the investor are mutual and that anything disadvantageous to the corporation is likewise disadvantageous to the investor, and to the banking house which offers the issue, and recommends it for a safe and profitable investment.

Meet Mr. Smith. He's Our Biggest Customer

A nation-wide survey of city and telephone directories recently completed shows that Mr. Smith is the best known gentleman in the United States. There are approximately 1,300,000 Smiths in the country. He has some close competition, however, in the Johnsons who number about 1,000,000. The Browns follow with about three-quarters of a million. These are followed by the Williamses, 685,000, Joneses, 658,000, Millers, 626,000, while the Davises boast 538,000 members.

Some interesting facts concerning the racial composition of different cities were revealed by the survey. In New York the Cohens have nearly tied with the Smiths for first place; in Boston the Sullivans are in second place and the Murphys in fifth; in Cincinnati the Meyers rank third.

Dakota Central Shows Steady Growth in Report

Aberdeen, S. Dak.—Approximately $540,000 will be spent for improvements and extensions by the Dakota Mutual Telephone Co. during 1927, according to decision made at annual meeting here. During 1926 the company added almost $400,000 to its property holdings and spent about $200,000 in improvements.

Painter Made Southwestern's General Attorney

St. Louis, Mo.—Earl H. Painter, attorney for Missouri for the Southwestern Bell Telephone Co., since 1922, has been promoted to the office of general attorney for the system, made vacant by the recent death of J. Willis Gleed. He is 38 years old and has been with the Bell system since 1912. During the World War he served with the Signal Corps. attaining the rank of Captain. He lives at 6826 Washington boulevard.

Edwin J. Bean, former member of the Missouri Public Service Commission for 11 years, was appointed to succeed Painter as attorney for Missouri in the legal department of the Bell system.

Southern Bell to Spend $29,700,000

Atlanta, Ga.—The Southern Bell will spend $29,700,000 as its part of the industry's expansion and improvement during 1927.

Jacksonville, Fla.—Approximately $4,000,000 will be spent in Florida as the Southern Bell's 1927 expansion program.

Michigan Telephone Co. Approved $23,525,000 Building Expenditure in 1927

Detroit, Mich.—The Michigan Bell Telephone Co., has approved $6,625,000 for extensions to plant. Approximately $3,400,000 of this total is for Detroit, $250,000 for Grand Rapids and the balance for the remainder of the state. The total amount approved in 1926 was $23,525,000.

Pennsylvania Bell O. K.'s $21,500,000 for 1927

Philadelphia, Pa.—Bell Telephone Co. of Pennsylvania will spend $21,500,000 for extensions during 1927. About $10,000,000 will be expended for outside plant.

Construction Program of N. Y. $74,901,921 in 1926

New York City—During 1926 the directors of the New York Telephone Co. authorized spending of $74,901,921 for new construction. Of this amount $60,059,521 was set aside for enlargement of plant facilities in the metropolitan area.

Middle Western Buying Illinois Properties

Springfield, Ill.—Application has been filed with the Illinois Commerce commission by the Citizens' Telephone company to sell to the Middle Western Telephone company its properties at Pekin, Havana, Lacon, South Pekin, Green Valley and Manito together with those of the Des Plaines Telephone company.

Reduced Charges Get Great Christmas Telephoto Play

New York City—Reduced charges for the sending of Christmas greeting photographs by the Bell telephoto system resulted in getting a large volume of this business.

Minier, Ill.—Minier Mutual Telephone Co. has been purchased by the Gary interests of Kansas City, Mo.

Detroit, Mich.—Michigan Telephone Co. directors during 1926 approved expenditure of $23,525,000 for plant extensions during 1926, divided approximately: $13,600,000 for Detroit, $750,000 for Grand Rapids and the balance, $9,175,000 for the remainder of the state.

Cimarron, Kan.—Authority for the sales of the telephone exchanges at Cimarron, Ingalls, Montezuma, Copeland and Pierceville, by J. W. Phelps to L. E. Mants and W. J. Knightley, has been granted by the public service commission.

BATTERIES (GG-2-16)

Primary Batteries

RADIO "B" BATTERIES. These batteries are employed for the relatively high plate potentials used with radio receivers, and consist of groups or "blocks" containing from 15 to 60 very small dry cells connected in series. Compared with the "A" batteries, the cells of the "B" battery supply but little current, a current of 60 milliamperes (0.06 ampere) being about the maximum drawn for even a ten or twelve tube receiver. The standard five tube receiver will pull from 15 to 25 milliamperes under ordinary working conditions and with the usual sound volume on the speaker. In most cases the individual cells are hardly larger than medium size flashlight batteries.

The most common commercial size "B" battery blocks are the 22.5 volt block of 15 dry cells and the 45 volt block of 30 dry cells in series. Intermediate taps are generally employed with these blocks so that a number of different voltages can be drawn to meet the requirements of the various types of radio tubes. With the 22.5 volt block there is generally a 16.5 volt tap, while on the standard 45 volt block the 22.5 volt tap is considered ample with the present day tubes. While 90 volt blocks (60 cells) are mnaufactured, they are seldom encountered in practice, for it is considered more convenient to attain the 90 volts by connecting two 45 volt blocks or four 22.5 volt blocks in series.

According to the service for which they are intended, the size of the blocks outlined above is divided into three classes: (1) The small portable or "light" blocks intended for portable receivers or very compact sets, (2) The "Standard" block used for receiving sets up to five tubes, and (3) The "Heavy-Duty" batteries with large cells used for five tubes and over, or else for receivers that are used for many hours at a time and where the price-economy must be reduced to a minimum. The "portable" type "B" batteries should only be used for portable receivers or for intermittent service, for they become exhausted so quickly that the renewals make continuous operation quite expensive. The "Standard" blocks are economical up to five tubes, but beyond five tubes or a continuous draft of more than 20 milliamperes, the "Heavy-Duty" batteries should be employed.

The voltages vary with different tubes and types of radio receivers. For single tube receivers using the soft tubes (Detector tube only), 22.5 volts will be all that is necessary. Where audio amplification is employed for loud speaker operation, at least 90 volts will be required for the audio frequency stage tubes or 135 volts for the audio tubes of resistance coupled or impedance coupled stages. The detector tubes of such multi-tube sets will require from 22.5 to 45 volts, according to type. The radio-frequency stages require from 45 to 67.5 volts on the plates in most receivers, while occasionally the receivers will be found to operate best with 90 volts on the R. F. stages.

BATTERIES (GG-2-17)

Primary Batteries

"B" BATTERY VOLTAGES. The following table will give the voltages ordinarily employed on the plates of the tubes and supplied by the "B" batteries. Where detector tubes are employed, be certain to note the voltage required for that particular tube used:

Service.	Type tube.	"B." Volts.		Location.
Detector tube.....	200	16.5	22.5	Simple detector set
Detector tube.....	200A	22.5	45.0	Any class of receiver
Detector tube.....	201A	22.5	67.5	Any class of receiver
Detector tube.....	199	22.5	45.0	Any class of receiver
Audio ampli. tubes....	201A	90.0	155.0	Transformer coupled audio stages
Audio ampli. tubes....	201A	120.0	135.0	Resistance coupled audio stages
Audio ampli. tubes....	199	80.0	90.0	Transformer coupled stages
Audio ampli. tubes....	120	120.0	135.0	Transformer coupled stages
Audio ampli. tubes....	112	135.5	157.5	Transformer coupled stages
Audio ampli. tubes....	371	157.5	180.0	Transformer coupled stages
Audio ampli. tubes....	310	200.0	425.0	Transformer coupled stages
Radio freq. ampli.....	199	45.0	50.0	Radio frequency stages only
Radio freq. ampli.....	201A	45.0	67.5	Radio frequency stages only

In general, a 20 per cent increase in voltage is required for resistance audio coupling over that specified as the proper voltage for transformer coupling owing to the losses or drop in the plate resistors.

"C" OR BIAS BATTERIES. The grid bias or "C" battery is a battery installed for maintaining a negative potential on the grids of the amplifying tubes. Used in the audio amplifying stages, the "C" battery very greatly reduces the consumption of "B" battery current, stabilizes the amplifying circuit against howling and self-oscillation, and adds considerably to the purity of reproduction. The "C" battery should be used in any amplifying stage, either radio or audio, when the plate or "B" voltage exceeds 45 volts. While the bias battery is sometimes used in the radio frequency stages, it is by far more commonly used in the audio amplifying circuit, where it works real economy. The following table gives the proper bias voltage for the various tubes and plate voltages:

Tubes.	"B" Volts.	"C" Volts.
201A	90.0	4.5
201A	135.0	9.0
120	135.0	22.5
112	90.0	4.5
112	135.0	9.0
171	90.0	16.5
171	135.0	27.0
171	180.0	40.5

Gary Buys British Columbia Telephone Co.

Kansas City, Mo.—Control of the British Columbia Telephone Co., operating nearly 100,000 telephones in British Columbia, with headquarters at Vancouver, has been purchased by the Associated T. & T. Co., the international interest of Theodore Gary & Co. and American and British associates.

The group of companies which are associated in this purchase, in addition to the foregoing, include Theodore Gary & Co., London; International Automatic Telephone Co., Ltd.; British Insulated Cables, Ltd.; Cable, Telephone & General Trust, Ltd.; Siemens Bros. & Co., London.

J. W. Perry, American capitalist, formerly president of Commerce Trust Co., Kansas City, is taking a substantial interest in the holding company formed to handle this operation and will be president of the holding company; and J. G. Crane, of Kansas City, who is president of the Gary company's operating telephone properties, will be a director and first vice-president.

It is expected that important interests in British Columbia will be associated in the ownership and management of the property. By reason of the operation of imperial preference it is expected that all apparatus and supplies will be furnished by Canadian and British manufacturers. No changes in policy or management are contemplated.

Freeman, S. Dak.—McGraw interests of Sioux City, Ia., have bought the Freeman Telephone Exchange.

Redfield, S. Dak.—Dakota Central Telephone Co. has bought controlling interest in the Redfield Telephone Co.

Elk Falls, Kan.—W. A. Beverlin, has bought the local exchange.

"Jack" White Joins American Electric at Kansas City

Kansas City, Mo.—H. A. White, known widely in the telephone trade

H. A. White

of the southwest as "Jack," has been appointed general sales representative of the American Electric Co., Inc., with headquarters at Kansas City. For 25 years White has been a factor in the telephone industry. The first 8 years of his telephone history were spent in building and operating plants. Then, for 17 years, he was with Kellogg's Kansas City branch. The last three years of his Kellogg service were spent in the capacity of branch manager at Kansas City.

In his work with American Electric, Jack will have charge of southwestern sales.

Kearney Guy Wire Serving Clip

BRIDGING twisted pair to twisted pair, a practical application of the Kearney Solderless Service Connector.

FOR Telephone Lines in making party line taps, order Cat. Number 86. The tap can't slacken off. This connector is for No. 12 wire or smaller

Assembled Connector

Kearney Guy Wire Clips Eliminate Serving End of Strand ! ! !

ASK ABOUT KEARNEY CERTIFIED MALLEABLE SCREW TYPE ANCHORS

JAMES B. KEARNEY CORPORATION ST. LOUIS, MO.

4226M Clayton Ave.

Illinois Appoints Committee on Legislation

Springfield, Ill.—Personnel of the Illinois Telephone Association's committee on legislative matters has been announced as:

George X. Cannon, Freeport, Illinois, Chairman.

Louis Pitcher, Dixon, Illinois.

Ben B. Boynton, Springfield, Illinois.

C. P. Cheadle, Joliet, Illinois.

E. R. Cogswell, care of Illinois Bell Telephone Co., Chicago.

H. G. Lankford, care of Illinois Bell Telephone Co., Chicago.

E. D. Glandon, Pittsfield, Illinois.

The Secretary-Treasurer of the Association (Ex officio).

United Announces Purchases of Four Companies

Chicago, Ill.—United Telephone Co. has bought the Marion (O.) County Telephone Co. at a price reported to be more than $1,000,000. Another recent United purchase involves The Albia (Ia.) Telephone Co. controlling interest. The Albia transaction also took in controlling interest of three other Iowa companies, the Eddyville Telephone Co., the New Sharon Public Utility Co. and the Toledo Telephone Co.

Further United buying in Iowa was the Harlan and Avoca Telephone Co., with headquarters at Harlan, Ia., into the United fold.

Two in One

Trouble Finder Portable Telephone

It simplifies line maintenance
Simple to operate and convenient to use.

Saves time, worry and many hardships

Locates trouble after dark
Eliminates wire cutting in testing

Provides the quickest way of locating line trouble.
Saves service revenue and avoids delays

It will pay for itself in a short time.

Full information furnished on request

The West Manufacturing Co.

447 Monadnock Block **Chicago, U. S. A.**

No. 4

Ready Pay-Out Reels

Best on the Market

Write for Price List and Discount at once

Ready Manufacturing Co.

Nasby Building **Toledo, Ohio**

TELEPHONE ENGINEER

Will buy practical telephone engineering editorial material at all times. Address Manuscripts to the Editor.

French Lick Springs Hotel

The All-Year Convention Site

French Lick Springs Hotel, accessibly located in the Cumberland foothills region of Southern Indiana is now more than ever the place for conventions with its new, 1500-seat convention auditorium, amply ventilated by outside windows on all four sides.

Healthful, natural spring waters of world-wide fame, two excellent 18-hole golf courses, horseback riding, tennis and hiking are among the attractions at French Lick. Rooms and meals are included in the rate. Before you leave home, you can tell, almost to a dollar, what your expenses will be. Write for illustrated booklet and details of convention facilities.

Address Convention Secretary

FRENCH LICK SPRINGS HOTEL COMPANY

French Lick, Indiana

"Home of Pluto Water"

Telephone Company Financing

THE Continental Telephone Company is an organization composed of men who have been prominent in the Independent field for many years, and are now operating successful properties. Headquarters for the Company are at St. Paul, Minnesota, and Lincoln, Nebraska.

The Continental Telephone Company invites correspondence from telephone companies anywhere in the United States, whether they are seeking funds for expansion or desiring to market their property.

When writing give number of stations, annual revenue, type of equipment and population served.

Continental Telephone Co.

Tri-State Telephone Building
St. Paul, Minnesota

Lincoln Telephone & Telegraph Bldg.,
Lincoln, Nebraska

Frank B. Cook, Veteran Independent, Dies in Florida

Monticello, Fla. — Frank B. Cook, pioneer Independent telephone inventor and manufacturer, of Chicago, died here, age 71, following a brief illness.

Mr. Cook was born at Monroe, Mich., Oct. 18, 1855 and started his business career as a cabinet maker. His inventive trend steered him into the telephone industry in 1878 when he was engaged in building telephone lines for William Kline, who was superintendent of telegraph for the Lake Shore & Michigan Southern Railway. He started regular exchange work in June, 1879, for the Toledo Telephone Exchange Co., which was later absorbed by the Central Union Telephone Co., a Bell subsidiary. He began as foreman of construction and filled various positions, including that of chief engineer in charge of all equipment and construction in a territory comprising some 200 exchanges in four states.

Mr. Cook resigned in 1896 and began the development of a line of telephone, switchboard, protective and distributive apparatus, most of which was the product of his own invention. He organized the Sterling Electric Co. of Illinois, which was operated at Chicago for a year, after which he moved the business to Lafayette, Ind.

The company met with success, and Mr. Cook remained as president until 1902 when he disposed of his interests to Walter Doolittle who continued the business for several years.

On retiring from the Sterling company, Mr. Cook returned to Chicago where he undertook the manufacture of telephone protective apparatus under his own name. In 1914 Mr. Cook incorporated the Frank B. Cook Co. He withdrew from active management the following year. In 1919 the name of the company was changed to the Cook Electric Co., which is still in successful operation.

Mr. Cook designed and built a semi-automatic telephone system which was installed at Fort Wayne, Ind. In recent years he had been interested in investments made in Florida and had spent much of his time there.

Surviving Mr. Cook are his widow, Mrs. Mary Raymond Cook; two daughters, Mrs. D. G. Ramsey and Mrs. C. C. Newburn, and a son, H. Roy Cook. He also leaves three brothers, James, Clarence and Edward Cook. The funeral services were held at the chapel, Chicago, 63rd street and Harvard avenue, January 3. Interment was at Mount Hope.

Pole Ad in This Issue Telephoned from New York

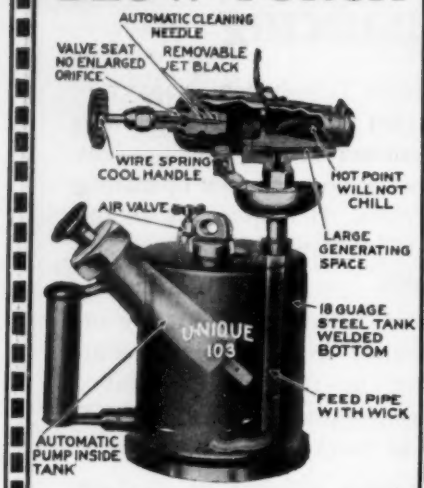
First use of the telephoto service in furnishing advertising copy for a telephone business journal is evident this issue in the advertisement of the International Creosoting and Construction Co. This advertisement was telephoned by the company's advertising agent in New York, to Chicago, plates made quickly and the copy hurried into print. Excellent legibility is apparent in all parts of the advertisement with the exception of the "Beaumont" address detail of the signature.

Probably some of the advertiser's own poles held part of the line over which the advertisement was transmitted, so the stunt carries the additional interest of this close tie-up.

This enlistment of a part of wire service that is growing rapidly in commercial popularity and profit to all concerned, makes its debut for the laudable purpose of promoting acute indigestion and starvation among wood-peckers and white ants that have been in the habit of banqueting on poles.

Dallas, Tex. — Southwestern Bell Telephone Co. is to start work on a $5,000,000 building here in April.

UNIQUE
BLOW TORCH



It starts quickly, operates in any position, and produces a remarkable heat. It is a great worker in cold and windy weather.

The automatic orifice cleaner, one of the details shown in the illustration, is but one of a number of exclusive features that make the Unique your greatest value in blow torches.

Painstaking care by interested workmen, an actual "burning test" before shipping, is just another detail responsible for their uniformity and efficient burning qualities.

Write for complete details

Unique Manufacturing Co.
113 N. Desplaines St. CHICAGO, ILL.

Everstick

Approved by Large Operating Companies For the Following Strains

6" 2-way	3,200 lbs.
6" 4-way	6,000 lbs.
8" 2-way	6,000 lbs.
8" 4-way	10,000 lbs.
10" 4-way	16,000 lbs.

Write for Details

Everstick Anchor Co.
ST. LOUIS, MO.

Make Your Directory a Source of Income
Write for Particulars
J. H. WELKER
McKinley Block, Canton, O.
Telephone 8009
DIRECTORY ADVERTISING EXCLUSIVELY

Fond du Lac, Wis.—Wisconsin Telephone Co. will spend $47,480 in extensions and improvements here in the near future.

Minnesota Plans Convention—St. Paul, Jan. 25-27

St. Paul, Minn.—The Minnesota Telephone association's 18th Annual Convention will be held in St. Paul on January 25th, 26th and 27th at the St. Francis Hotel. All exhibits will be on the second floor.

"With the prospects before us for 1927, Minnesota offers to the manufacturers and jobbers of the telephone industry the most fertile field for new business during the coming year, with the large number of operating telephone exchange companies and over 1,600 rural line telephone companies, its State Conventions second only to the National Convention in attendance and enthusiasm," says J. C. Crowley, secretary of the association at the coming Convention.

Northern White Cedar Men Convene Jan. 25-26

Minneapolis, Minn.—On January 25 and 26 the 31st annual meeting of the Northern White Cedar Association will be held at Minneapolis. N. E. Boucher, 702 Lumber Exchange Bldg., Minneapolis, is secretary of the association.

Texas Independent Convention at Fort Worth, March 15-18

Fort Worth, Tex.—The next annual convention of the Texas Independent Telephone Assn. will be held March 15-18, 1927, at the Texas Hotel, Fort Worth.

The Convention Calendar

SOUTH DAKOTA
Sioux Falls, Cataract Hotel, January 11, 12 and 13.

MINNESOTA
St. Paul, St. Francis Hotel, January 25, 26 and 27.

NEBRASKA
Lincoln, Lincoln Hotel, February 15, 16 and 17.

NORTH DAKOTA
March 8, 9 and 10.

OKLAHOMA
Oklahoma City, Huckins Hotel, March 8, 9 and 10.

TEXAS
Fort Worth, Texas Hotel, March 15, 16, 17 and 18.

KANSAS
Manhattan, April 5, 6 and 7.

NEW YORK
Rochester, Powers Hotel, May 25, 26 and 27.

Susank, Kan.—Susank Telephone Co. has bought local exchange from Hoisington-Stickney Telephone Co.

Winters, Tex.—West Texas Telephone Co. will move into its new exchange building here about March 1.

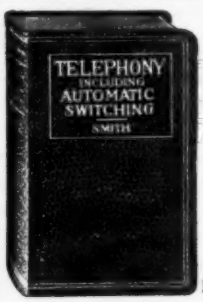
Cook B-7 substation arresters each . . . $.50

W. E. 122-W exposed binding post receivers . .50

S. C. No. 988 common battery desk stands with No. 1136 steel bell boxes . . . 5.00

BUCKEYE TELEPHONE AND SUPPLY CO.
COLUMBUS, OHIO

Only $39.00
For This Highest Grade Auto Trailer
½ Ton Capacity.
Three styles of body to choose from. Can furnish extension tongue for hauling poles, solid rubber tires. Light weight, easy-running. Write for catalogue.
Bower Mfg. Co., 15 Ade St., Fowler, Ind.



A Great Practical Book *for the* Practical Telephone Man

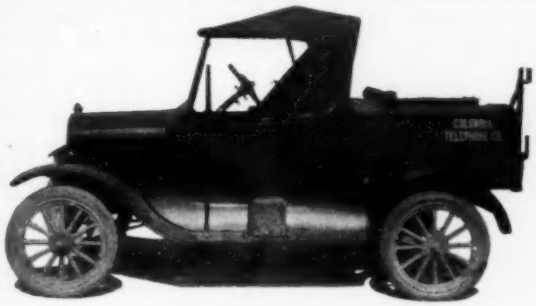
TELEPHONY
including
AUTOMATIC SWITCHING
By Arthur Bessey Smith

The following brief outline shows the scope of this work: The magneto receiver, local and common batteries, instruments, private lines and exchange, multiple and "feature" switchboards, automatic switching and telephone instruments, 100, 1000 and 10,000 line exchange, party lines, multi-office exchange, large city systems, private automatic exchange, power plants, testing and adjusting, toll, phantom circuit, loading of lines, measured service, index.

The price of TELEPHONY, including AUTOMATIC SWITCHING, is $2.50
TELEPHONE ENGINEER
225 N. Michigan Ave. Chicago, Illinois

T. W. TURNER—Cable Splicing and Repair Work. Jobs done by Hour or Contract. Satisfaction Guaranteed.
Deerwood, Minnesota

Perkinsville, Ind.—Local telephone plant has been sold by Madison Apgar to M. R. Thoma of Shirley.



Type SC-172

Cabinet Body for Ford Roadster

A STRONG, light-weight, convenient cabinet body used in connection with the standard Ford roadster. Soon repays its first cost. Standard equipment with some of the largest telephone and power companies. Equipment includes ladder irons and rear fenders.

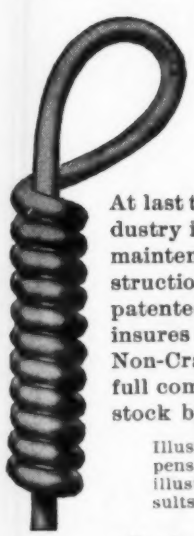
Write for Bulletin No. 214 giving prices and full information

HOOVER BODY CO.

YORK, PENNSYLVANIA

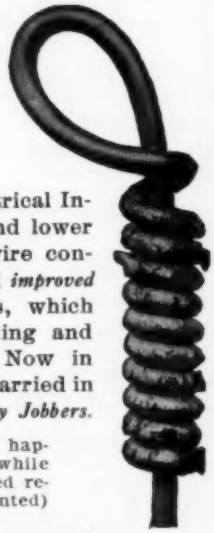
"INDIANA"

Double Galvanized Telephone and Telegraph Wire



Crapo Patents

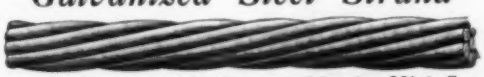
Non-Peeling
Non-Cracking



At last the Telephone and Electrical Industry is assured longer life and lower maintenance on galvanized wire construction through our *new* and *improved* patented Galvanizing Process, which insures a wire with Non-Peeling and Non-Cracking Zinc Coating. Now in full commercial production. Carried in stock by Representative *Supply Jobbers.*

Illustration at right shows what happens to old process galvanizing, while illustration at left shows assured results of Crapo process—(patented)

Galvanized Steel Strand



Standard or Commercial, Siemens-Martin, High Strength and Extra High Strength Grades

Indiana Steel & Wire Co., Muncie, Ind.

KESTER SOLDER

Rosin-Core

In the telephone field Kester Solder is the standard for both maintenance and production work. The comprehensive line of Kester Solder embraces a range of sizes from approximately 1/4″ to 1/16″ in diameter. Standard Acid Core diameter, being 1/8″ and Standard Rosin Core diameter 3/32″. Packed on one, five, ten and twenty pound spools, there is a range of size and style of package suitable for every practical purpose.

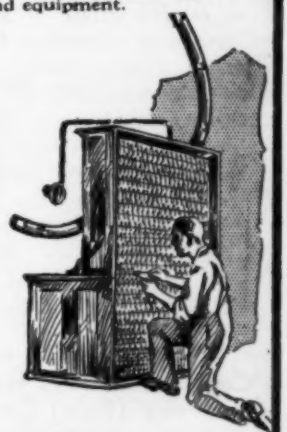
For heavier electrical work Kester Acid Core Solder can be used with considerable saving in time, labor and material.

For the more delicate electrical work on switchboards, etc., only Kester Rosin Core Solder should be used. Its pure rosin flux eliminates every danger of corroded work.

Most telephone companies specify Kester Rosin Core Solder No. 2, 50 core for cable line splicing as it not only conforms with the standard specifications, but also speeds up this class of work.

Kester Solder either rosin or acid core is handled practically everywhere by jobbers of telephone supplies and equipment.

We maintain a completely equipped research laboratory where we have solved soldering problems for many manufacturers. While our standard line of Kester Solder is adequate for practically every soldering job there are occasions where a specially developed solder and flux are required.



Consult our Research Engineer on your soldering problems

"Requires Only Heat"

CHICAGO SOLDER COMPANY

4218 Wrightwood Avenue Chicago, U. S. A.

Originators and world's largest manufacturers of Self Fluxing Solder

Thurber Retires as New York Board Chairman

New York City.—Howard Ford Thurber, chairman of the board of directors of the New York Telephone Co., has retired from the company. His resignation inspired the adoption of resolutions commenting on his exceptional service, by the company's board.

Mr. Thurber's retirement comes at the completion of nearly 37 years of telephone service during which he rose from an engineering assistant to the highest office in the largest of the associated companies in the Bell system. His entire business career has been spent in the telephone industry in which he has been a leader of outstanding engineering and organizing ability. J. S. McCulloh, president of the company said that no one has contributed more to the upbuilding of his company, than has Mr. Thurber.

Born in Brooklyn, August 6, 1869, Mr. Thurber acquired his early education at the Polytechnic Institute and first became interested in the telephone while a student at Cornell when he attended a lecture by Dr. Alexander Graham Bell. Inspired by Bell's talk, Mr. Thurber chose the telephone business as a life work.

After leaving Cornell in 1890 with the degree of mechanical engineer, he entered the engineering department of the Metropolitan Telephone & Telegraph Co., the predecessor of the New York Telephone Co.

Following three years of apprenticeship, Mr. Thurber was made assistant chief engineer and in 1894, at the age of 25, became general superintendent, an office which he filled for 12 years. He was then appointed general manager of the company and two years later, in 1908, he was elected vice-president and general manager. In 1912 he was elected vice-president of the eastern group of Bell Telephone Companies, operating throughout the Middle Atlantic States.

In October, 1919, Mr. Thurber was elected president of the New York Telephone Co., resigning as vice-president of the Bell Telephone Co. of Pennsylvania and the Chesapeake & Potomac Telephone Co. and their associated companies. He was elected chairman of the board of directors of the New York company in September, 1924.

Continental Buys Ord and Kearney (Neb.) Companies

Lincoln, Neb.—Continental Telephone Co. has bought the Kearney Telephone Co., with headquarters at Kearney, and the Farmers Mutual Telephone Co., of Ord, which owns exchanges at Ord and Burwell, with 2,000 stations and switches for an unusually large number of farm lines. A competing exchange, operated by another farmers' mutual company, is located at Burwell, but the bulk of the business is controlled by the Ord company.

Warren Pratt, one of the pioneers in Independent telephony in Nebraska, and at present head of the state telephone association, is president of the Kearney company. W. L. Clapp is secretary and treasurer and W. W. Johnson, general manager. It operates approximately 3,000 stations, and does a good switching and toll business, having 150 miles of toll lines of its own. It has exchanges at Kearney, Riverdale and Sumner.

The capital stock of the company is $140,000, of which $90,000 is common. This was purchased by the Continental. The company has a bonded indebtedness of $80,000; property valued at $333,000, a depreciation reserve of $79,000 and a surplus of $24,000. It has been operated at high efficiency, and has been paying dividends regularly.

The Ord company had a peculiar history. The city is located in Valley county, the second county north of Buffalo, in which Kearney is situated. Originally a group of farmers living south of Ord built a number of lines into the city, and hooked up with the company owned by local business men. The farmers north of town also built into Ord, but put in an exchange of their own.

The double system resulted in both companies losing money, but the situation was ended some years ago by the Farmers company buying out the town company. Since then it has done a great deal of reconstruction work, the plant being in excellent condition at the present time.

With increased rates it has been a profitable enterprise. On a capital stock of $36,000 it earned during 11 months of 1925 a net of $4,000. It has property valued at $85,000, a depreciation reserve of $19,500 and a surplus of $20,000. Alvin Blessing is president and O. P. Bailey, secretary and treasurer.

J. H. Agee, vice-president of the Continental and general manager of the Lincoln Telephone & Telegraph Co., conducted in large part the negotiations for the plants purchased. He says the Continental engineers are planning extensive improvements and additions in the properties.

This gives the company a total of 25,000 stations, of which 12,000 are in Nebraska and 13,000 in southwestern Iowa. The company recently acquired plants at important towns

Enduring Investments

THERE is one question to which every prospective investor should demand a satisfactory answer before parting with his money:—Will the investment endure?

If the industry is a basic one upon which a large part of the people are dependent for daily necessary service—

If the management is efficient and experienced—

If the business has an established record of growth and development—and its prospects for future growth are substantial—

The investment will endure to the profit and lasting satisfaction of the owners of its securities.

Independent Telephone Companies' securities answer this question admirably at every point.

These securities are enduring investments.

PAUL C. DODGE & CO.
INCORPORATED
INVESTMENT SECURITIES
10 SOUTH LA SALLE STREET
CHICAGO

BRACH VACUUM ARRESTERS

at prices within your reach

When the best protection costs no more, why not have it? BRACH arresters insure; non-grounding of lines, cables, clear transmission, balance of potential between pairs, and full protection against power crosses or lightning. There are no carbons to clean and no maintenance bills.

You can readily afford BRACH Vacuum Arresters at our present low prices. Type 440, showr above, is furnished with porcelain base, fuses and mountings.

L. S. BRACH MFG. CO.
NEWARK, N. J.

Nearly Half a Million in Use

Vacuum Grip PLIERS
REG. U.S. PAT. OFFICE

No. 58—8½" Professional pattern, lineman pliers Also furnished in 6 and 7".

TEST THEM!
Against Any Other Make

YOUR NAME ETCHED FREE ON HANDLE PROTECTS YOU AGAINST THEFT

Let us send you a pair or two for running test against any other make of plier you may be using, or have ever used. Test them in any way you see fit. If they are better pliers—for "hang," cutting, gripping, twisting power and in all other respects—you can't afford not to use them regularly. A running test will determine the question *for you*.

Do not compare VACUUM Grip Pliers with the ordinary commercial product. They are forged from electric furnace tool steel, hardened and tempered thru and thru—not case *hardened!*

SOLD WITH AN UNQUALIFIED GUARANTEE—not only against defects in material and workmanship but to give the user 100% plus satisfactory service. No questions asked; the user's judgment goes.

Thirty-five sizes and patterns, including special designs for repairmen and switchboard workers. Send for Catalog T-1 showing complete line and for selecting samples for running test.

TO PURCHASING AGENTS: Send for samples for test in the hands of your workmen.

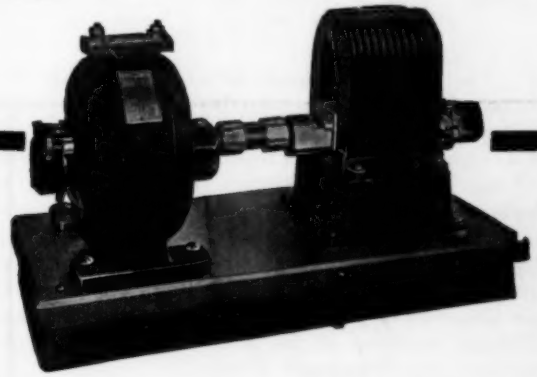
FORGED STEEL PRODUCTS CO., *Newport, Penna.*

For Maximum Service—Baker Contact Points

DEPENDABILITY and long life are the two essentials in a contact point. This "heart of the machine" should function evenly and steadily over long periods of time—it should not need replacement at frequent intervals.

Baker Contact Points are made with this principle always in mind and the name "Baker" assures that perfect performance, without constant renewal, which is the outstanding characteristic of a *good* contact point. Our contacts are made of Platinum, Iridio-Platinum, Silver and Special Alloys. There are sizes and types for all purposes.

BAKER & CO., INC.
54 Austin St., Newark, N. J.
NEW YORK CHICAGO



Holtzer-Cabot
MAGNETO—RINGING—MOTOR—GENERATOR

Dependable Service!

This ringing equipment never fails. No attention is required except occasional lubrication.

Once installed your ringing troubles are over and your ringing service is 100%.

Send for illustrated circular. Or better still, give it a test in your exchange. We stand back of the machine.

The Holtzer-Cabot Electric Co.
125 Amory St., Boston, Mass.
6161 So. State St., Chicago, Ill.

Chicago, St. Louis and New York Are Cable Joined Now

Chicago, Ill.—Chicago and St. Louis now are joined by telephone cable. In a brief ceremony December 15, the new cable formally was put into commercial service between the two cities and at the same time telephone cable communication became continuous between New York and St. Louis by way of Chicago, the New York-Chicago cable having been opened last year. The first conversation between Chicago and St. Louis were talks by President W. R. Abbott of the Illinois Bell Telephone Co., with President E. D. Nims of the Southwestern Bell Telephone Co. in St. Louis; and between W. R. Dawes, president of the Chicago Association of Commerce, and Harold M. Bixby, president of the St. Louis Chamber of Commerce. Walter S. Gifford, president of the American Telephone and Telegraph Company, and James Brown, chairman of the executive committee of the Chamber of Commerce of the State of New York, also talked from New York to Chicago and St. Louis. The Chicago-St. Louis cable was constructed jointly by the Illinois Bell, American Telephone and Telegraph, and Southwestern Bell companies. It is 344 miles long, required two years to build, and cost approximately $7,000,000. While not exactly uniform throughout, the cable is made up, in general, of from 500 to 600 copper wires and the whole is covered with a lead-antimony sheath about two and five-eighths inches in diameter. Loading coils are connected to the wires at intervals of approximately 6,000 feet, and repeaters are connected to the circuit at intervals of either 50 or 100 miles. The cable is in underground conduit for 51 miles through cities, and is strung on poles for 293 miles in the open country.

The cable will provide more than 250 telephone circuits and more than 500 telegraph messages can also be sent simultaneously with the telephone conversations.

Existing open wire lines will continue to be used in most sections for an indefinite time, and the two types of plant, cable and open wire, will supplement each other. The cable will make it possible to give faster and more uniform long distance service which will be practically free from the interruptions of sleet and wind storms.

In the Chicago-St. Louis cable are 169,000 miles of wire and 11,875 poles. The total weight of the cable is 14,500,000 pounds, of which the sheath alone weighs 8,700,000 pounds. About 1,300,000 wire splices were made.

Cables also are in use between New York and New Haven, New York and Philadelphia and Chicago and Milwaukee, the last named, underground all the way. The New York-Chicago cable also reaches South Bend, Toledo, Cleveland and Pittsburgh. Further cable extensions are planned from Chicago to Omaha, from Milwaukee to Minneapolis and St. Paul, from St. Louis and Kansas City to Dallas, Tex., and from Washington, D. C. to Atlanta, Ga.

W. R. Abbott, president, Illinois Bell Telephone Co., speaking at Chicago during the formal opening of the new Chicago-St. Louis cable. At Mr. Abbott's left is W. R. Dawes, president, Chicago Association of Commerce

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New York City.—Bancroft Gherardi, vice president and chief engineer of the A. T. & T. Co., has been nominated for the presidency of the American Institute of Electrical Engineers.

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